Relithia Energy

www.relithia.mydurable.com

BUILDING THE FUTURE OF E-WASTE RECYCLING

- Innovation
- Sustainability
- Collaboration

Sustainable Development

Nigeria | Zimbabwe
RECYCLING AND MANUFATURING
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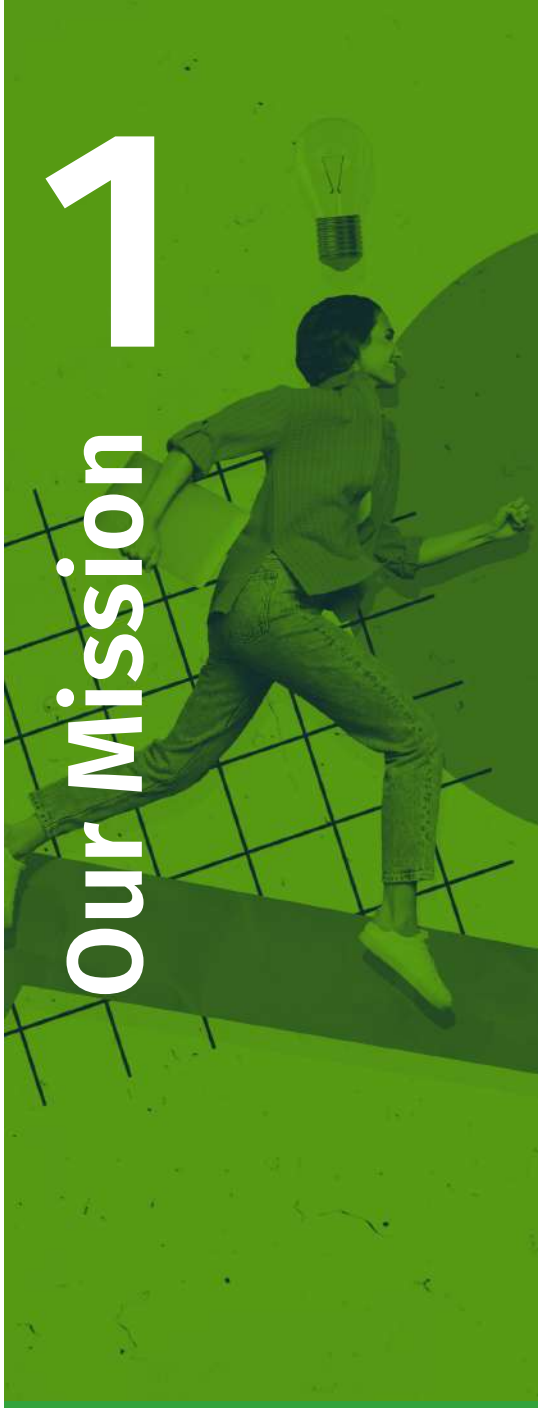
2025



1 Our Mission

To Harness cutting-edge engineering innovations to tackle Africa's most critical challenges, drive economic growth through job creation and sustainable industires, and champion environmental stewardship by promoting responsible waste management and circular economic practices.

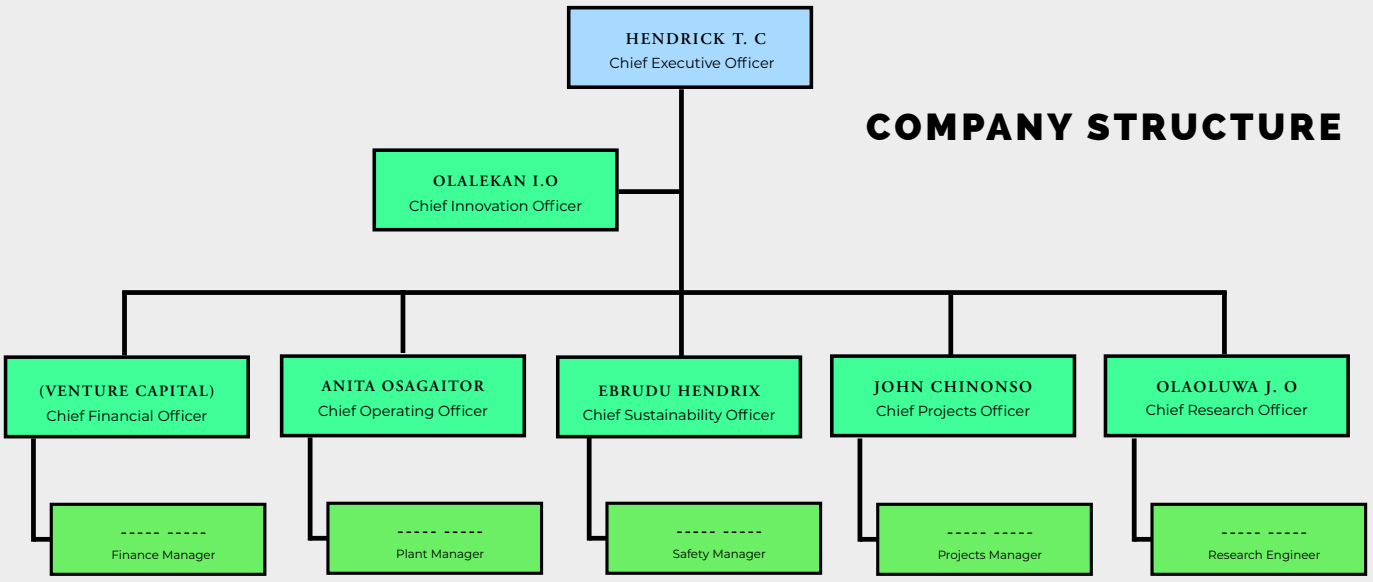
2 Our Vision

To create 15 million jobs in Africa's clean energy sector by 2034.

EXECUTIVE SUMMARY

Relithia Energy's journey began as a research project among passionate engineering students across Africa, united by a shared vision to harness engineering solutions to address the continent's pressing challenges. Initially known as the Association for Engineers in Science and Technology (AEST), the initiative has since transitioned into a pioneering startup, revolutionizing the way Africa approaches energy storage and electronic waste management.

Founded in 2023 by a team of visionary engineers, including Engr. Hendrick T. Chikwanha and Olalekan Olowe, Relithia Energy is at the forefront of developing a comprehensive closed-loop ecosystem for circuit boards recycling, lithium-ion battery recycling and manufacturing. Our innovative approach transforms discarded batteries and circuits boards into valuable raw materials, which are then repurposed to produce high-performance prismatic lithium-ion cells, driving Africa towards a sustainable and circular energy future.



The Organogam of the Company

Background Information

Vast amount of valuable metals occurs in electronic waste, which can be extracted for re-use. Considering the mechanical and structural properties of electronic waste, an environmental method can be used to extract valuable metals. The proposed project is anticipated to expand to all countries in Africa in a period of eight years using the Fibonacci series.

ReLithia ENERGY

TEAM SPOTLIGHTS

Hendrick Tafadzwa Chikwanha

Chief Executive Officer

henrychacks@gmail.com

- World Federation of Engineering Organization Fellow
- African Federation of Engineering Fellow
- Royal Academy of Engineering Fellow
- International Association of Engineers member number 172960
- Zimbabwe Institute of Engineers member
- Charted Chemical Engineer

Olalekan Isaiah Olowe

Chief Innovation Officer

label.isaiah@gmail.com

- International Association of Engineers (IAENG) Member Number 379818
- Electrical and Electronics Engineer
- Python and Automation developer
- IOT, Artificial Intelligence, and Data Science
- Research and Development

Olaloluwa John Adeleke

Chief Research Officer

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- Electrical Engineer
- Research and Development

John Chinonso Edeh

Chief Projects Officer

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Anita Osagiator Ekogiawe

Chief Operation Officer

ekogiaweanita@gmail.com

Eburu Hendrix Obukome

Chief Sustainability Officer

hendrixobucks@gmail.com

Venture Capital Firm

Chief Financial Officer

- Open position to the venture capital firms on condition of equity

DEPARTMENTAL BREAKDOWN

Position	Key Responsibilities
Chief Executive Officer *Executive Director*	• Sets overall strategic direction for the company. • Oversees all operations and resources. • Represents the company in external forums. • Ensures financial sustainability and growth. • Makes high-level decisions about policy and strategy. • Manages organizational structure. • Creates the vision for the company. • Responsible for hiring and firing senior management.
Chief Innovation Officer *Executive Director*	• Leads development of new recycling and manufacturing technologies. • Manages research and development (R&D) activities. • Identifies emerging technologies and trends. • Drives innovation through research and development. • Evaluates and implements new technology and systems for both recycling and battery manufacturing process. • Responsible for patent and intellectual property generation.
Chief Sustainability Officer *Executive Director*	• Develops and implements sustainability strategies. • Ensures compliance with environmental regulations. • Oversees environmental impact assessments. • Ensures recycling processes are effective. • Sets and monitors sustainability goals. • Manages relationships with environmental organizations.
Chief Operating Officer *Executive Director*	• Manages day-to-day operations. • Oversees production, supply chain, and logistics. • Ensures operational efficiency and effectiveness. • Manages personnel and resources. • Establishes and maintains operational policies and procedures. • Ensures that the plant is functioning effectively on a daily basis.
Chief Research Officer *Executive Director*	• Leads basic and applied research efforts. • Manages research teams and resources. • Identifies research priorities. • Collaborates with external research institutions. • Publishes research findings. • Responsible for analyzing results. • Responsible for research into more cost effective ways of recycling and manufacturing.

Chief projects Officer *Executive Director*	• Oversees all capital projects. • Manages project budgets, timelines, and resources. • Ensures projects are completed on time and within budget. • Coordinates project teams and stakeholders. • Responsible for delivering the project to its end goal. • Responsible for implementing the vision.
Chief projects Officer *Executive Director*	• Manages financial planning, reporting, and control. • Oversees budgeting, accounting, and auditing. • Ensures compliance with financial regulations. • Manages investments and cash flow. • Reports directly to the CEO
Projects Manager	• Manages specific projects related to expansion. • Coordinates project activities. • Monitors project progress and performance. • Reports to the Chief Projects Officer. • Ensures the team has everything it needs to be effective and deliver to expectations.
Finance manager	• Prepares financial reports and statements. • Manages accounting operations. • Administers payroll and benefits. • Reports to the CFO. • Responsible for day to day accounting and financial planning.
Research Engineer	• Conducts applied research and development. • Develops new recycling and manufacturing processes. • Analyzes data and prepares reports. • Works under the direction of the Chief Research Officer. • Responsible for all engineering aspects of the research and development phases.
Plant Manager	• Oversees day-to-day operations. - • Manages production schedules. • Ensures quality control. • Manages plant personnel and resources. • Reports to the COO. • Responsible for overseeing both staff and plant effectiveness and efficiency.
Safety Manager	• evelops and implements safety programs. • Ensures compliance with safety regulations. • Conducts safety training and inspections. • Investigates accidents and incidents. • Reports to the COO or Plant Manager. • Responsible for the safe daily running of the plant.

PROBLEM STATEMENT

Africa have witnessed a rapid surge of imports of mobile phones, laptops, smart TV usage in recent years. While this growth has brought undeniable benefits like improved connectivity and economic opportunities, it has also cast a shadow in the form of a burgeoning problem: electronic waste. This issue is further compounded by the historical trend of Africa being a destination for electronic waste from developed countries and also factors below.

Over time, there has been a decline in the global e-waste collection and recycling rate, which stood at 22.3 percent in 2022. The ITU target to increase the rate to 30 percent by 2023 seems unattainable in the light of that trend. However, if there is a shift in momentum and adequate e-waste management infrastructure is put in place, the global e-waste collection and recycling rate might be increased to at least 38 percent by 2030.

IMPROPER DISPOSAL OF ELECTRONIC WASTE WHICH LEADS TO THE RELEASE OF TOXIC CHEMICALS LIKE LITHIUM. COBALT. LEAD. TIN. IRON

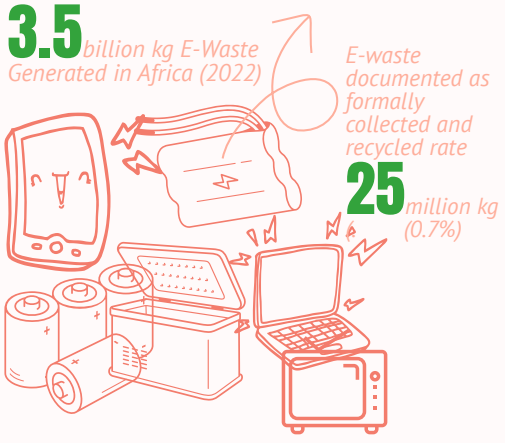
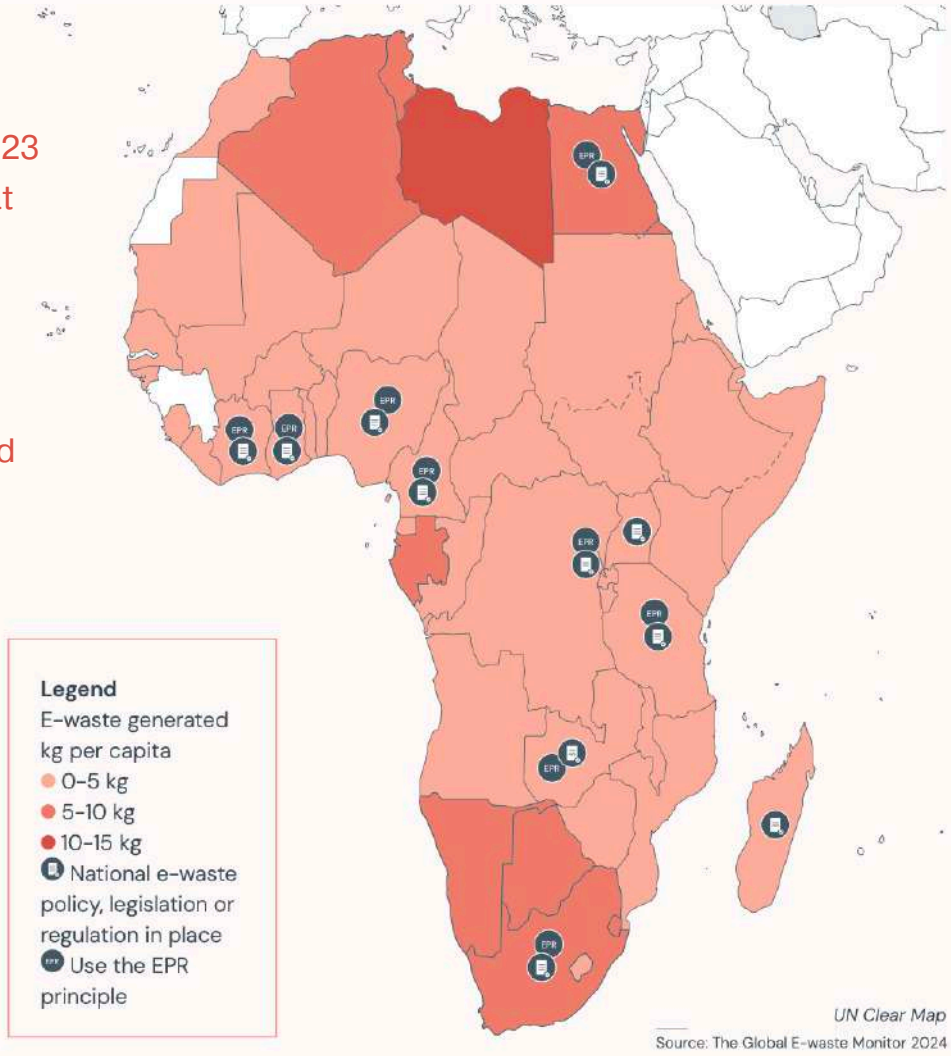

3.5 billion kg E-Waste Generated in Africa (2022)
E-waste documented as formally collected and recycled rate
25 million kg (0.7%)

Figure 1: E-waste Status In africa.



Source: The Global E-waste Monitor 2024

COUNTRIES WITH THE HIGHEST E-WASTE GENERATION IN THE REGION

Total million kg		kg per capita	
1. Egypt	690	1. Libya	14
2. South Africa	530	2. Seychelles	14
3. Nigeria	500	3. Mauritius	12
4. Algeria	330	4. Equatorial Guinea	11
5. Morocco	180	5. South Africa	9

Figure 2:

Quantity of EEE imported in Africa

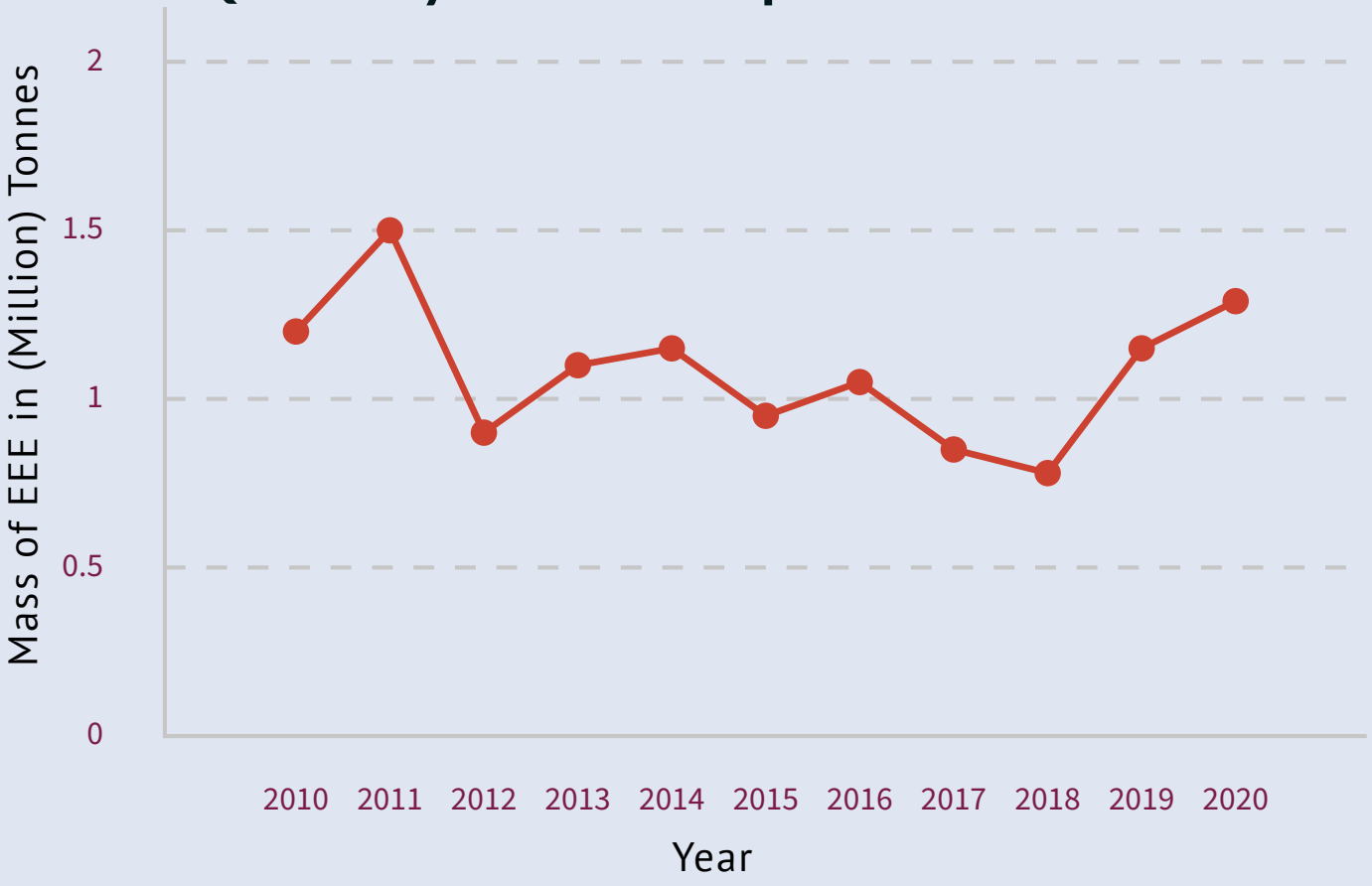
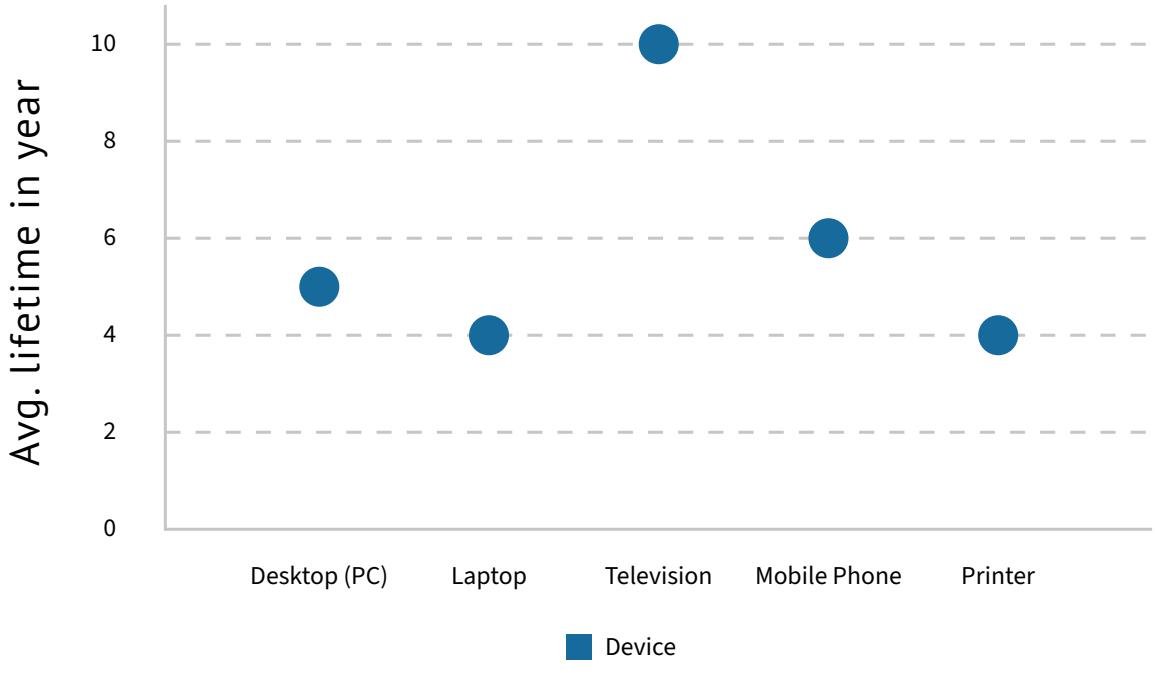


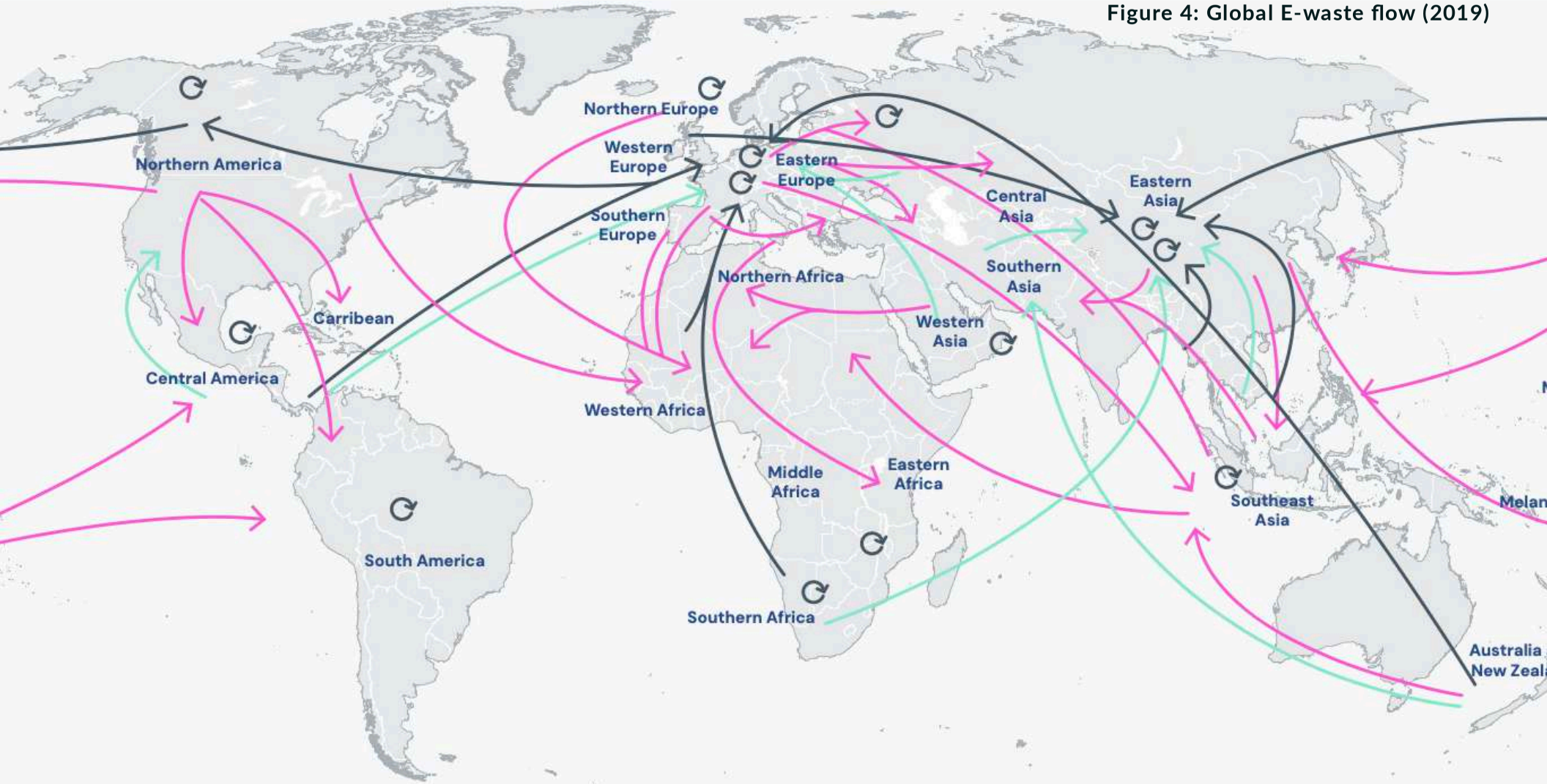
Figure 3: Lifespan of some EEE



Source: *Bisoyi, Dr & Das, Biswajit. (2018). An Approach to En Route Environmentally Sustainable Future Through Green Computing (SCOPUS, WEB OF SCIENCE). 10.1007/978-981-10-5544-7_61.*

TRANSBOUNDARY MOVEMENT

Figure 4: Global E-waste flow (2019)



oted from C.P. Baldé, E. D'Angelo, V. Luda O. Deubzer, and R. Kuehr (2022), Global Transboundary E-waste Flows Monitor – 2022, United Nations Institute for Train
Research (UNITAR), Bonn, Germany. Available at: https://ewastemonitor.info/wp-content/uploads/2022/06/Global-TBM_webversion_june_2_pages.pdf.

COUNTRIES WITH THE HIGHEST E-WASTE GENERATION IN AFRICA Total million kg (Fig 5)

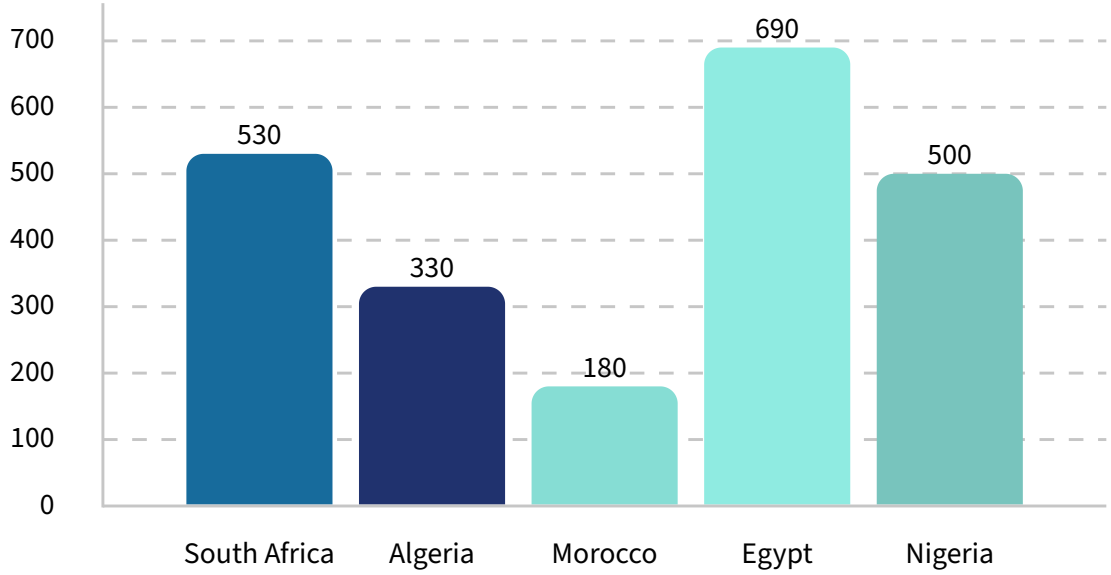
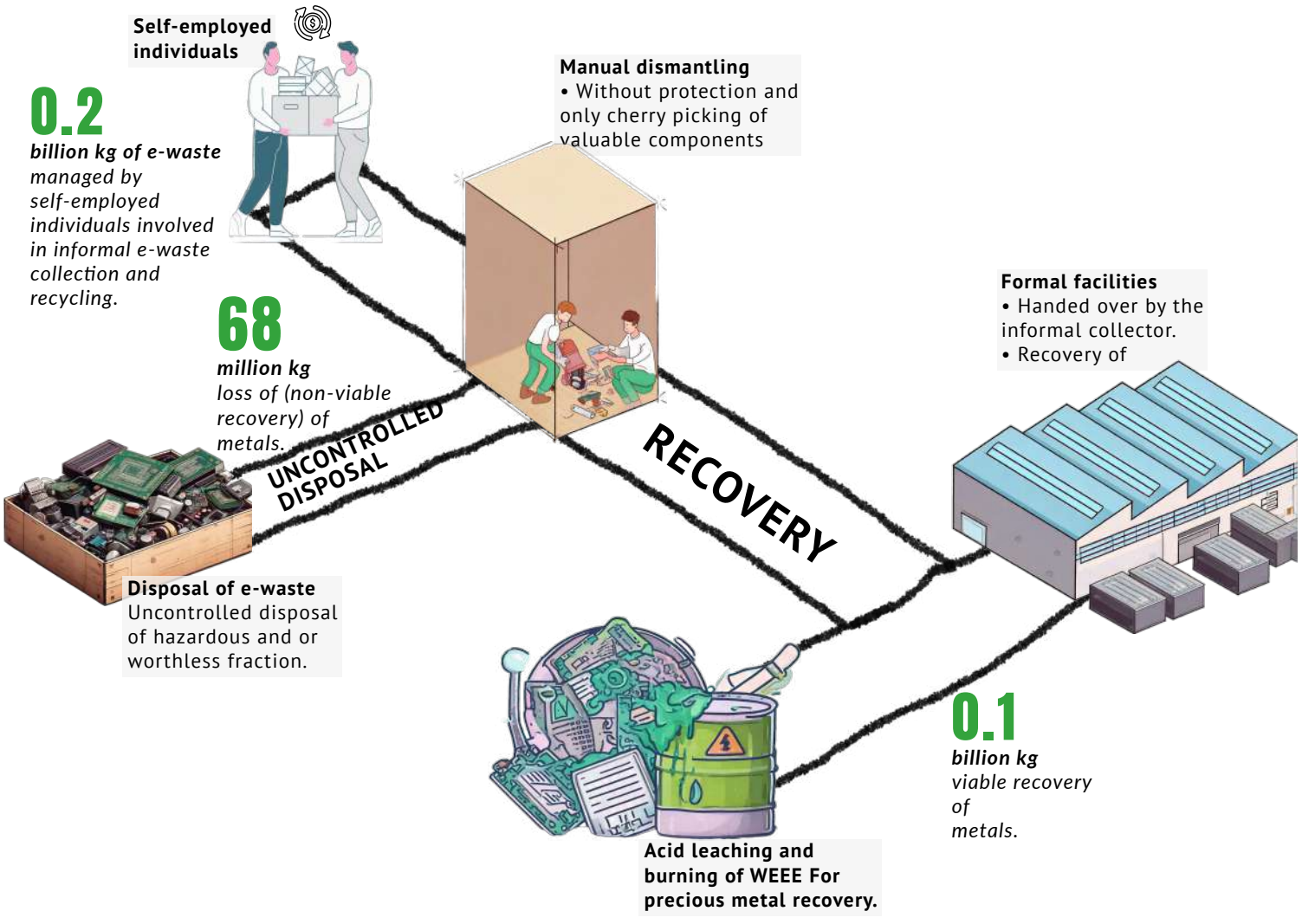


Figure 6: E-waste Collection and Recycling Outside Formal Systems with No Developed E-waste Management


Self-employed individuals
0.2
billion kg of e-waste managed by self-employed individuals involved in informal e-waste collection and recycling.
Manual dismantling
• Without protection and only cherry picking of valuable components
68
million kg loss of (non-viable recovery) of metals.
UNCONTROLLED DISPOSAL
RECOVERY
Formal facilities
• Handed over by the informal collector.
• Recovery of
Disposal of e-waste
Uncontrolled disposal of hazardous and or worthless fraction.
0.1
billion kg viable recovery of metals.
Acid leaching and burning of WEEE For precious metal recovery.

Source: Graphics by Relithia Energy

Economic Assesent

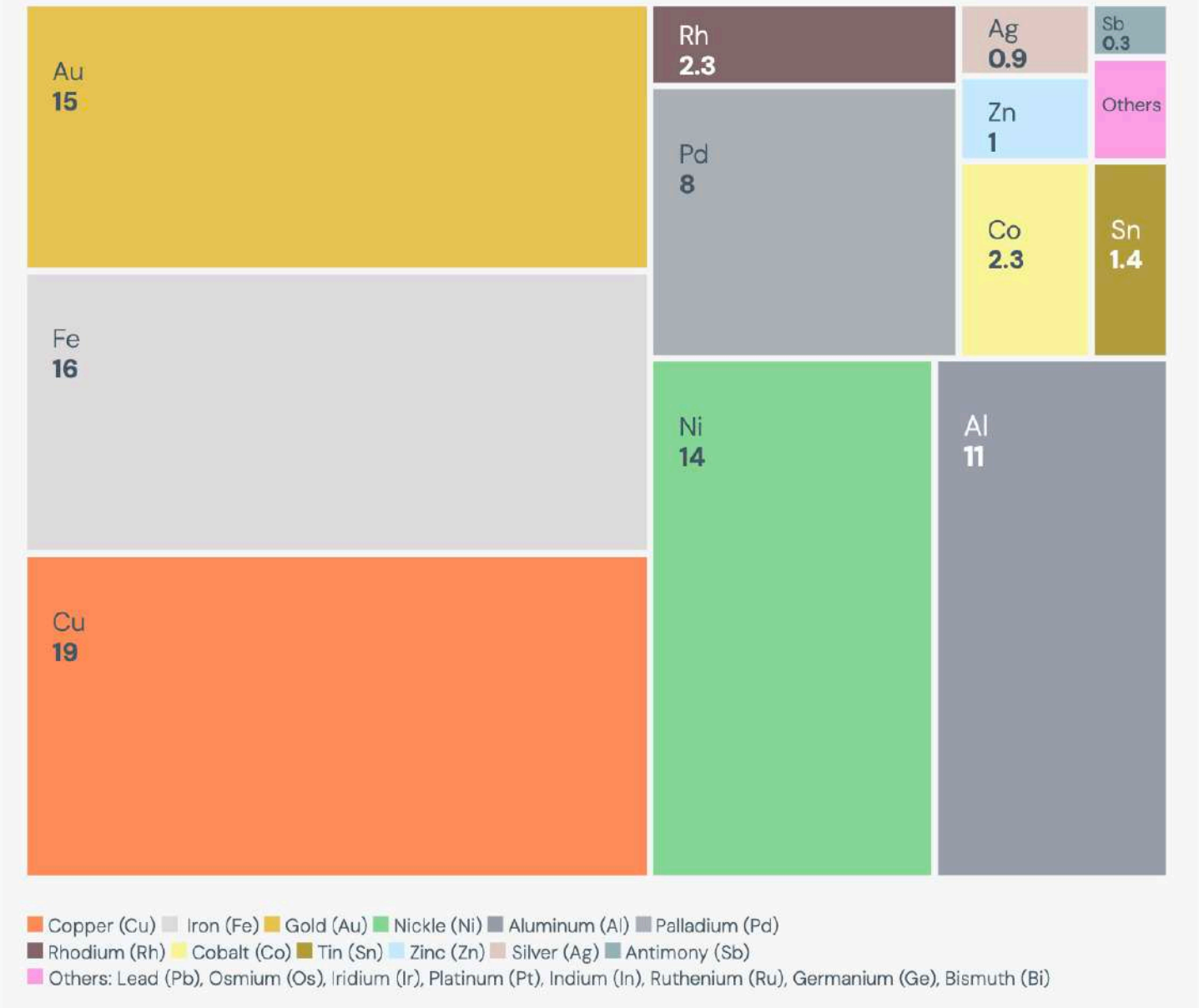
SOURCE: THE GLOBAL E-WASTE MONITOR 2024

Current e-waste management practices result in around USD 28 billion worth of metals being turned into secondary raw materials worldwide in 2022. However, the overall impact of e-waste management represents a net cost of approximately USD 37 billion, mainly in the form of externalized health and environmental costs arising from unmanaged hazardous substances and emissions of greenhouse gases.

In 2022, the overall gross value of the metals contained in e-waste was estimated at USD 91 billion.

Most of the potential value in secondary raw materials in e-waste lies in copper (USD 19 billion), gold (USD 15 billion) and iron (USD 16 billion). These metals can be efficiently reclaimed with high recycling rates using current e-waste management technologies and in current financial conditions.
That said, not all metals are recycled into secondary raw materials in an environmentally sound manner, owing to the low global collection rate of 22.3 per cent, and significant amounts are managed by the informal sector

FIG 7. ECONOMIC VALUE OF METALS FROM E-WASTE (BEFORE MANAGEMENT) IN USD BILLION (2022)



Source: The Global E-waste Monitor 2024

WASTE PRINTED CIRCUIT BOARDS (WPCB)

PCBs, the base of electronics, are essential and common components of almost all electronic systems. PCBs are used to mechanically support and electrically connect ECs using conductive pathways, tracks, or signal traces etched from Cu sheets laminated onto a nonconductive substrate. PCBs, which provide the interconnection between software and hardware, are found in all EEEs. The annual average world PCB manufacturing rate increases by 8.7% and is much higher in China and Southeast Asia. The average amount of e-waste in PCBs is 3% 5% and is higher in some EEEs, like TV sets (7%), computers (19%), and mobile phones (21%). PCBs include transistors, capacitors, heat sinks, integrated circuits/chips (ICs), resistors, integrated switches, processors, etc. Most recycling approaches can only recover the metal contents of PCB scraps to the extent of 30% of the total weight. More than 70% of PCB scraps cannot be efficiently recycled and recovered and are incinerated or landfilled. PCB processing, separating, and recycling allow the recovery of: small ferrous components (stainless steel and Fe), metals (Cu, Al, Sn, and Pb), PMs (Au, Ag, and Pd) and an organic, inert fraction (plastics).

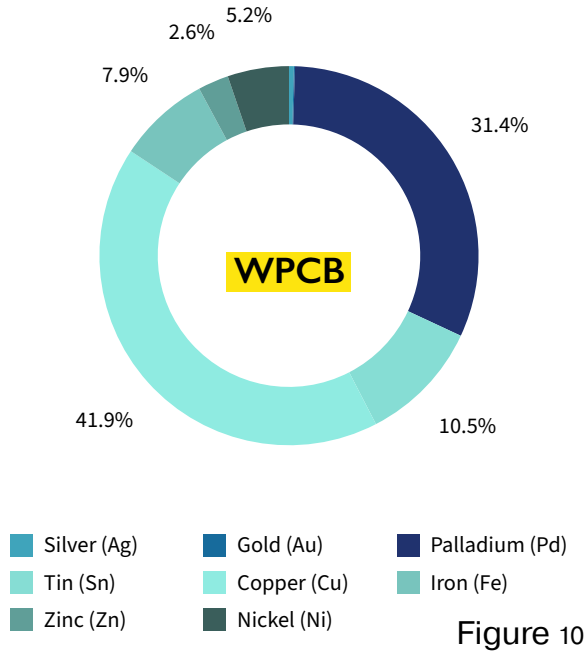


Figure 10

The presence of precious metals such as gold, silver, palladium, and platinum makes recycling highly lucrative. At a rough estimate, one-third of the weight of Waste Printed Circuit Boards (WPCBs) consists of metals, mainly Cu (~16%), Sn (~4%), Fe(~3%), Ni (~2%), and Zn (~1%). In addition, Preciuos Metals (PMs) like Au (0.039%), Ag(0.156%), and Pd (0.009%), which are used as contact materials or plating layers because of their electric conductivity and chemical stability are 10 times more abundant in WPCBs than in natural ores.

These concentrations are 10 times higher than in natural ores, making WPCBs a goldmine for urban mining. For instance, the recycling of Au and other PMs from WPCBs in China generated $2.6 billion in 2007, with additional contributions from other metals totaling $0.4 billion.

We have established competitive procurement costs for raw materials:

- END-OF-LIFE LITHIUM-ION BATTERIES: $73/MT
  PRINTED CIRCUIT BOARDS: $120/MT

The vast population and growing economic landscape of Africa present an immense opportunity for Relithia Energy. With over 1.3 billion people on the continent, nearly every individual owns or interacts with electronic and electrical equipment (EEE) which creates a substantial base of potential e-waste. Additionally, the business sector contributes significantly to the generation of e-waste, with approximately:

- 5.3 million micro organizations ,
- 2.05 million small organizations ,
- 521,910 medium-sized organizations , and
- 172,050 large organizations

The amount of Au recovered from 1 ton of PC e-waste is more than that recovered from 17 tons of Au ore. Generally, 300 g Au can be extracted from 1 ton of waste mobile phone recycling, but only 3 g of Au can be extracted from 1 ton of average natural Au ore.

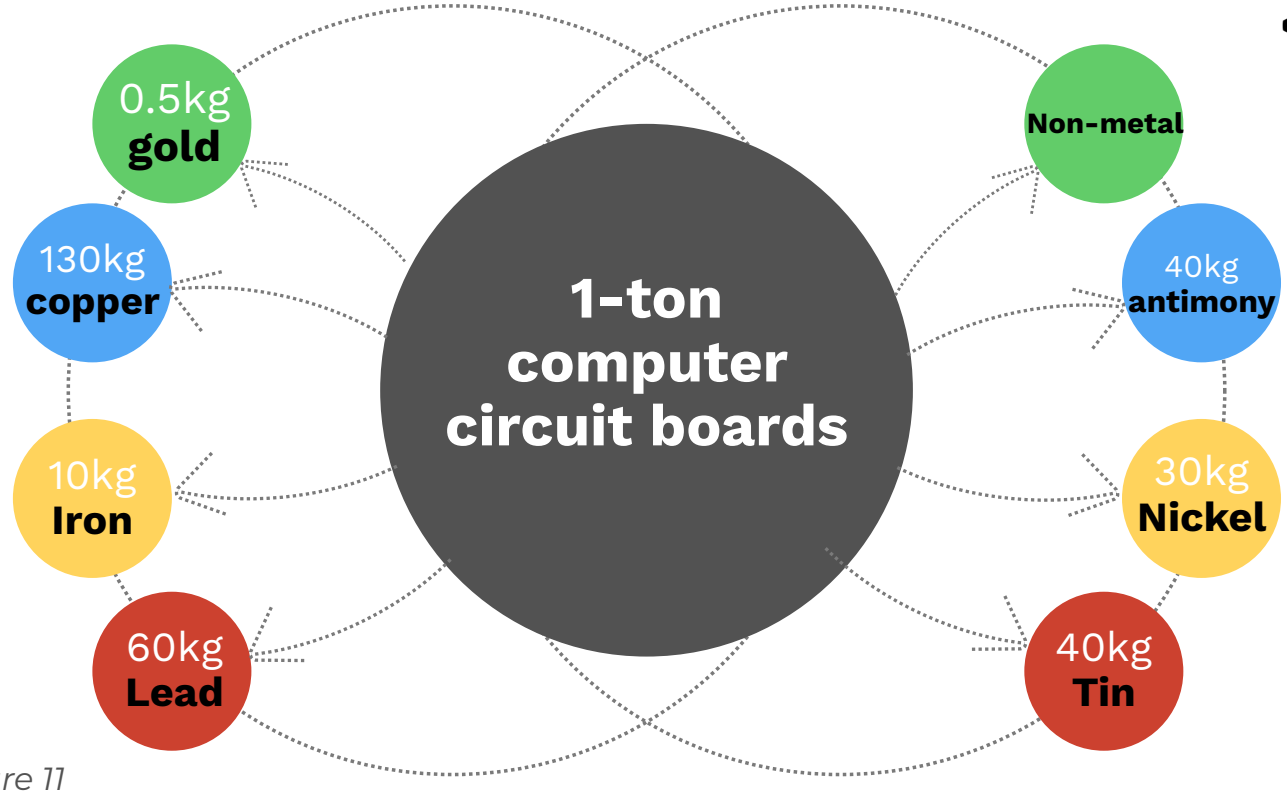


Figure 11

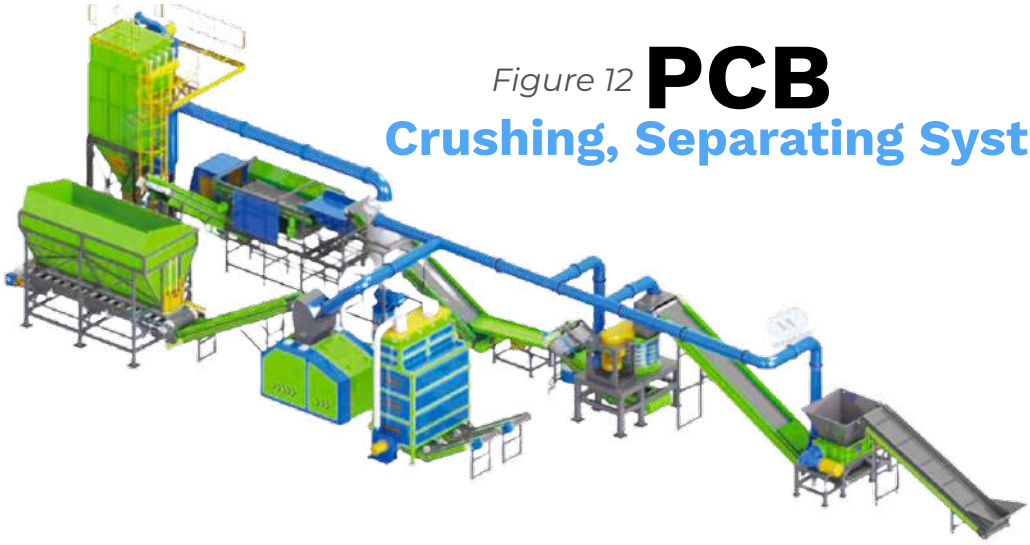


Figure 12 **PCB**
Crushing, Separating System

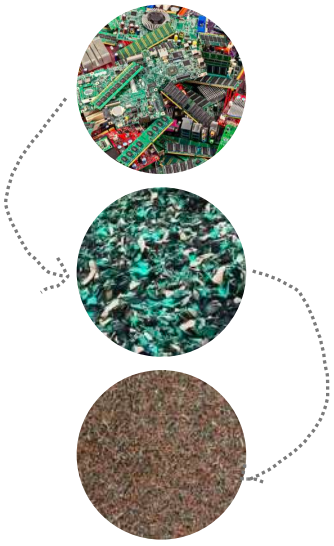


Figure 13 Waste Computer, Cell Phone, TV Board, Scrap PCB Board Recycling Machine

RECOVERY RATES

E-waste is rich in valuable metals, including: *Iron/Steel (Fe), 24 billion kg Aluminu (Al), 4 billion, kg Copper (Cu), 2 billion kg.*
Smaller quantities of precious metals like gold (Au), palladium (Pd), and silver (Ag) are also present, totaling 1.6 million kg
These metals have high market values, hence, highly consequential to our business model

Current e-waste management practices recover about 60% of total metals, 4% of other metals, and 20% of precious metals ***(according to a report by E-waste Global Monitor)***. However, this leaves significant room for improvement. For instance, 12 billion kg of metals were lost in 2022 due to inefficient or non-compliant recycling processes. We aim to capitalize on these lapses with our proprietary recyling line that acheives 97%+ recovery of these precious metals (PMs).

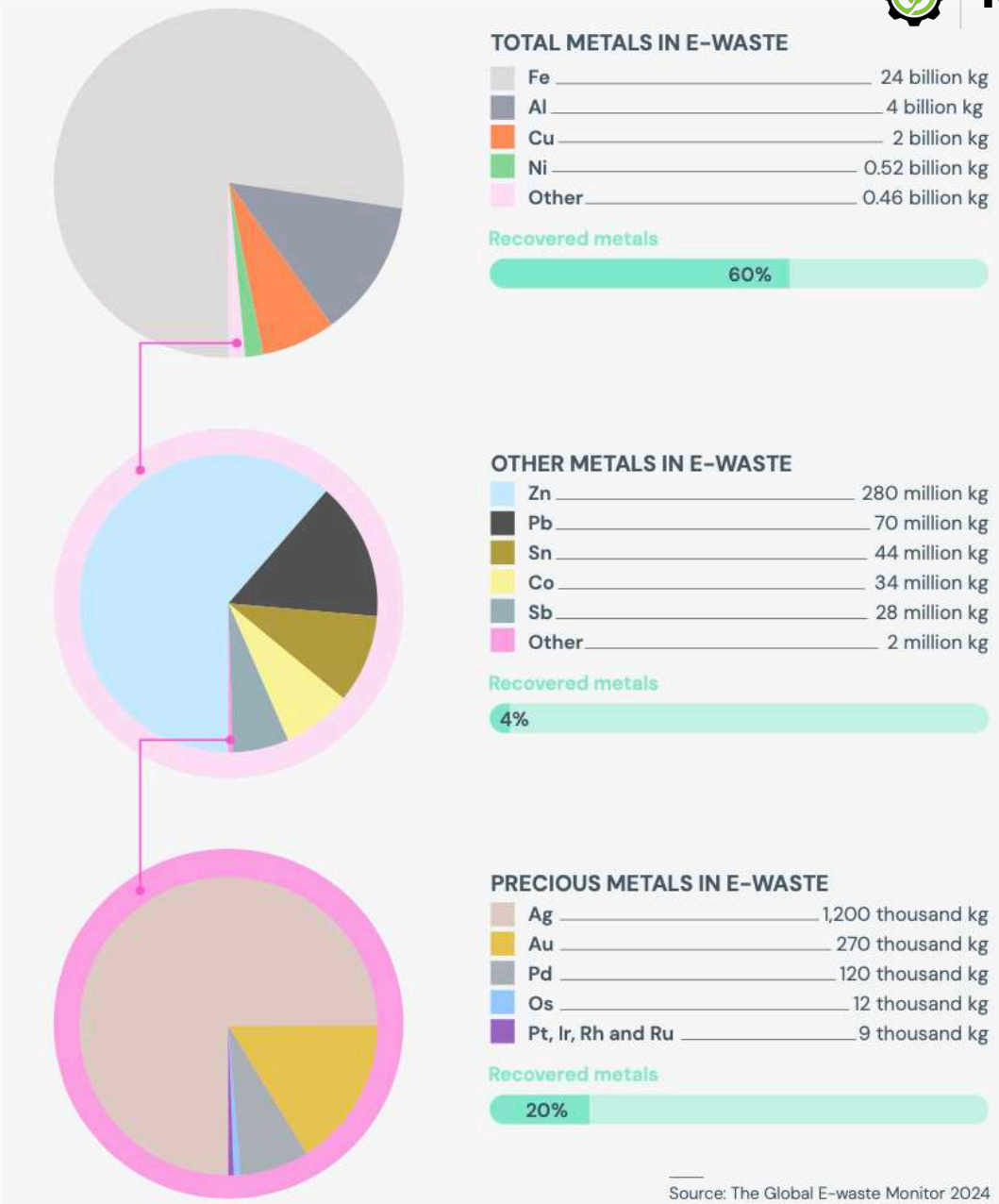


Table 1: Key e-waste statistics, top 10 in Africa (2022)

COUNTRY	POPULATION (2022) (EST. IN MILLION)	E-WASTE GENERATED (MILLION KG)	E-WASTE GENERATED (KG/CAPITA)	E-WASTE DOCUMENTED AS FORMALLY COLLECTED AND RECYCLED (MILLION KG)	NATIONAL E-WASTE LEGISLATION/ POLICY OR REGULATION IN PLACE	EPR FOR E-WASTE	COLLECTION TARGET IN PLACE	RECYCLING TARGETS IN PLACE
Egypt	113	692	6,3	N/A	Yes	Yes	No	No
South Africa	62	527	8,8	22,9	Yes	Yes	No	No
Nigeria	223	497	2,3	N/A	Yes	Yes	Yes	No
Algeria	45	333	7,5	N/A	No	No	No	No
Morocco	37	177	4,8	N/A	No	No	No	No
Angola	36	148	4,2	N/A	No	No	No	No
Sudan	49	103	2,2	N/A	No	No	No	No
Libya	7	94	13,8	N/A	No	No	No	No
Kenya	54	88	1,6	N/A	No	No	No	No
Ethopia	125	88	0,7	N/A	No	No	No	No

PATENTS

Between 2010 and 2019, the share of patent applications related to e-waste recycling modestly increased from 148 per million to 220 per million. But after 2019, this trend accelerated dramatically, reaching 787 apps/million in 2022. Despite this growth, only 11% of these patents are dedicated to PCB recycling. This underrepresentation is notable given the high concentration of valuable and critical raw materials in PCBs, which remain relatively stable compared to other components like cables or lamps. Our patents will be targeting both PCBs and lithium-ion batteries which is our proprietary low-temperature pyrolysis and mechanical separation technology that achieves over 97% recovery rates for rare earth element.

Figure 14: Patent Applications for E-waste Recycling Technologies by Total Applications

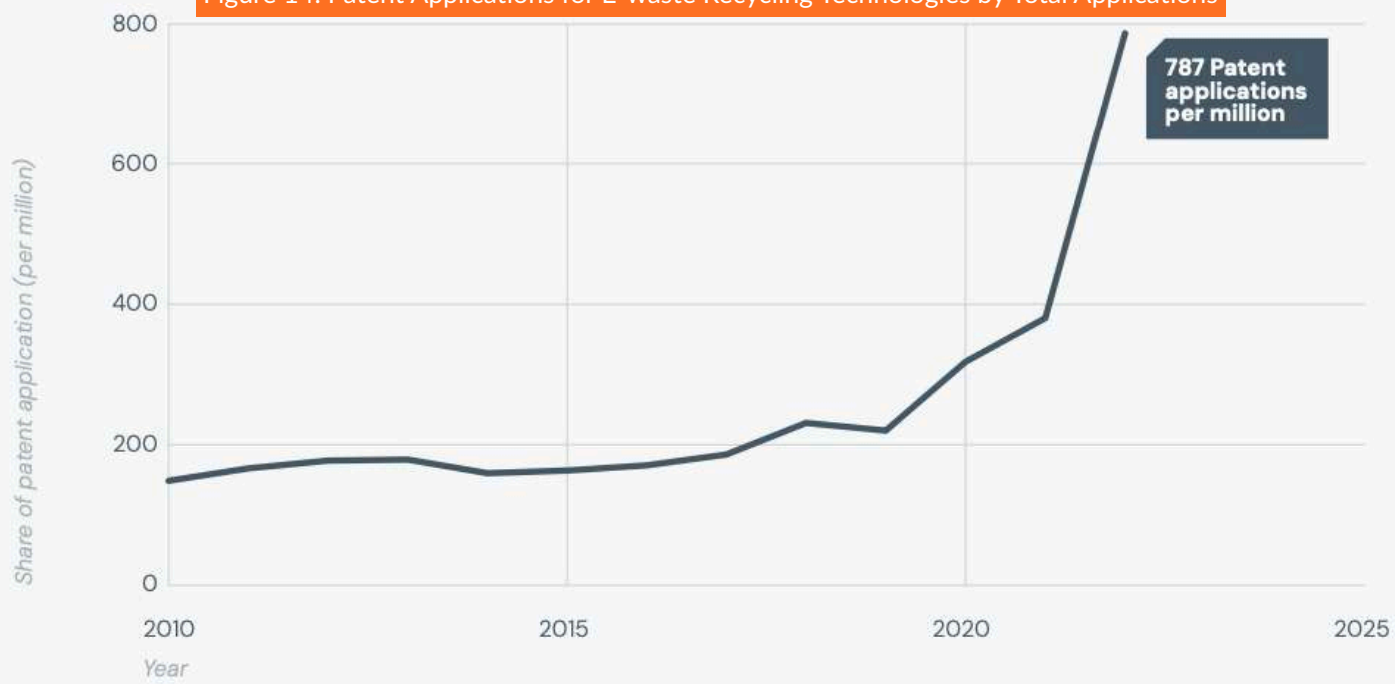
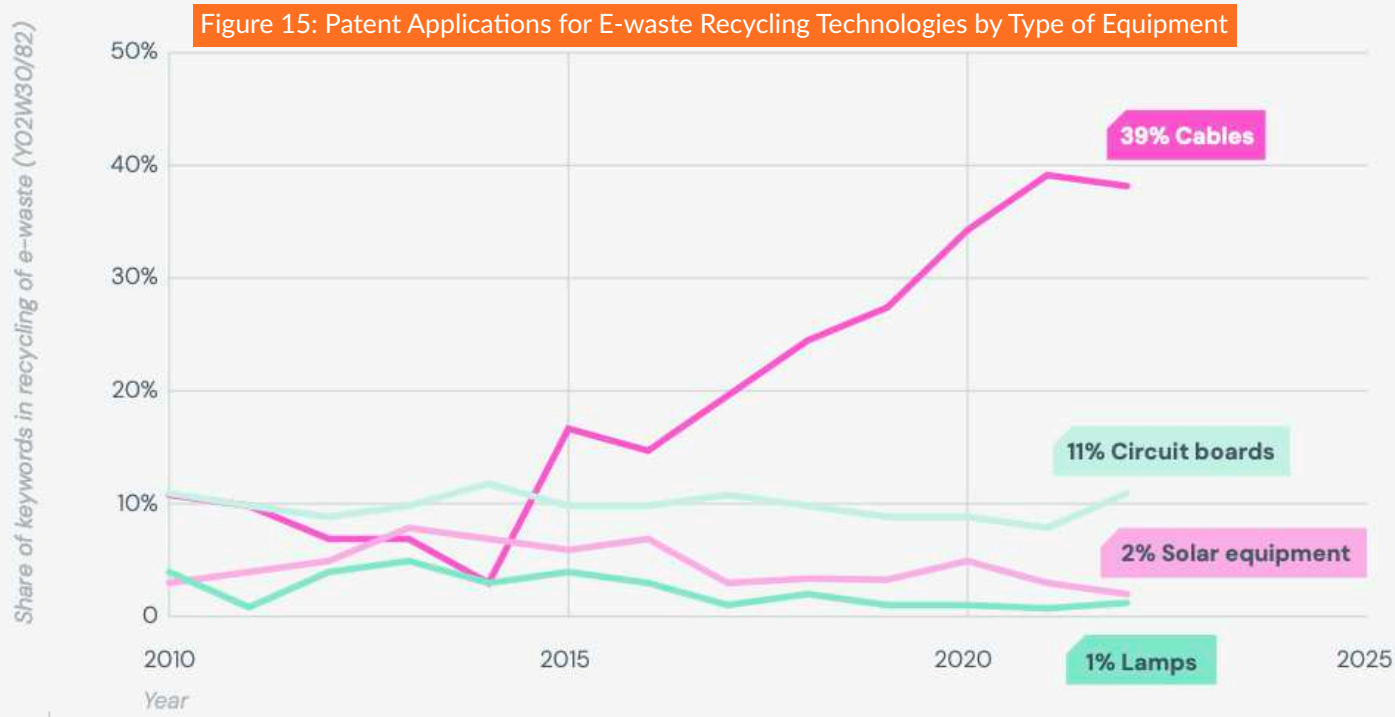


Figure 15: Patent Applications for E-waste Recycling Technologies by Type of Equipment



Source: The Global E-waste Monitor 2024

PROPOSED SOLUTION

Our recycling process is unique and eco-friendly, utilizing a low-temperature pyrolysis technique at 375.15K to safely decompose hazardous components such as carbon pentafluoride from lithium-ion batteries. This method avoids the high energy consumption associated with traditional pyrometallurgical processes and eliminates the need for chemical leaching used in hydrometallurgy. Following pyrolysis, we employ a series of mechanical steps, including crushing and separation, to achieve a recovery rate of over 97% for rare earth elements (REEs).

OUR FACILITY IS DESIGNED TO HANDLE UP TO 300KG/HOUR FOR BOTH PCB AND LITHIUM-ION BATTERY RECYCLING LINES, WITH PLANS TO SCALE CAPACITY AS DEMAND GROWS.

The profitability of our operations hinges on the chemistry of the materials we recycle. Lithium-ion batteries, particularly those with NMC (Nickel-Manganese-Cobalt) chemistries, offer the highest returns due to their rich content of valuable metals like cobalt and nickel. In African markets, LCO (Lithium Cobalt Oxide) batteries dominate consumer electronics, providing a steady supply of lithium, cobalt, and nickel for recovery.

COMPOSTION HIGHLIGHTS

Figure 8a

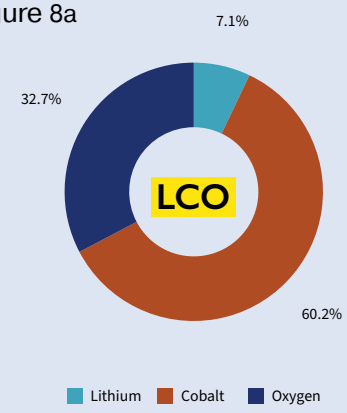
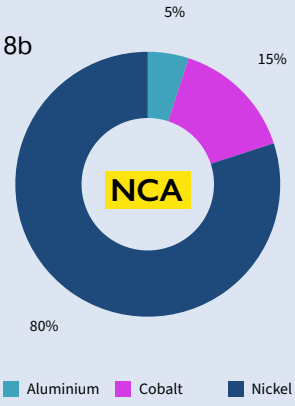


Figure 8b



RAW MATERIALS UTILIZED

Figure 9a SCRAP ELECTRONICS

Figure: 9b LITHIUM BATTERIES

WASTE PCB

Figure: 9c

SUSTAINABILITY

"There is no such thing as 'away'. When we throw anything away it must go somewhere."

- ANNIE LEONARD

Sustainable Development Goals (SDGs)

At Relithia Energy, we are deeply committed to aligning our operations with the United Nations' Sustainable Development Goals (SDGs). Our mission is not just about recycling e-waste but also about stimulating a sustainable future for all. Here's how we comply and adopt key SDG goals:

1

No Poverty

Our vision is to create millions of jobs in the clean energy sector, significantly boosting employment rates thereby reducing poverty levels across Africa,

3

Good Health and Well-being

Proper e-waste management is crucial for public health. By safely decomposing hazardous materials and preventing toxic substances from entering the environment, we protect human health and well-being

4

Quality Education

Over the next decade, our financial plan includes funding scholarships for engineering students across Africa. This initiative equips young minds with quality education in renewable energy, empowering them to drive innovation and contribute to a greener future.

5

Gender Equality

We are dedicated to promoting gender equality by ensuring that both men and women have equal opportunities in the clean energy sector.

7

Affordable and Clean Energy

By locally sourcing of E-waste and transforming them into secondary source of raw materials, we drastically reduce production costs for new energy storage equipment.

9

Industry, Innovation, and Infrastructure

We contribute to building resilient infrastructure and promoting sustainable industrialization with an efficient recycling technology.

11

Sustainable Cities and Communities

Our efforts in e-waste management help create sustainable cities and communities. By reducing waste and promoting resource recovery, we contribute to cleaner, healthier urban environments that support long-term sustainability.

12

Responsible Consumption and Production

We strive to minimize waste and maximize resource recovery. Our high recovery rates of rare earth elements reduce the need for new raw material extraction, supporting responsible consumption and production patterns.

13

Climate Action

Through efficient recycling processes, we mitigate environmental degradation and greenhouse gas emissions. By reducing hazardous materials sent to landfills and minimizing energy-intensive extraction methods, we actively combat climate change.

14

Life Below Water

Our operations promote the collection of hazardous waste that could otherwise end up in water bodies or landfills [SDG 15].

15

Life on Land

By actively stimulating controlled E-waste disposals, we protect both aquatic and terrestrial ecosystems, safeguarding life below water and on land.

1 NO POVERTY
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
14 LIFE BELOW WATER
15 LIFE ON LAND
5 GENDER EQUALITY
7 AFFORDABLE AND CLEAN ENERGY
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
SUSTAINABLE DEVELOPMENT GOALS

Are Investors Still Investing in Sustainability?

This page investigate the findings of research conducted in December 2024 by Kearney and We Don't Have Time, surveying more than 500 CFOs across several geographies, including the United Kingdom, the United States, the United Arab Emirates and India, to unxderstand if and how CFOs are embedding sustainability into their strategies.

NINETY-TWO PERCENT OF CFOS SAY THEY WILL INVEST MORE IN SUSTAINABILITY. WITH MORE THAN HALF SAYING THEY WILL SIGNIFICANTLY INCREASE THEIR INVESTMENTS.

Throughout 2024, there was a growing concern that investments in the green economy would face a slowdown. However, study by Kearney and We Don't Have Time clearly indicates this is not the case. Quite the opposite in fact. Out of the more than 500 CFOs who responded to the survey, 92 percent say they will increase their current investments in sustainability, with more than half saying they will significantly increase their investments.

When asked about the focus areas of their sustainability investments, CFOs prioritize initiatives with tangible, near-term impacts on emissions reduction:

1. Increase the use of sustainable materials.
2. Drive sustainable innovation and partnerships.
3. Manage energy.
4. Reduce waste.
5. Focus on ESG regulations and ratings.

Other priorities include decarbonizing supply chains, educating the workforce, reducing travel, and offsetting emissions.

Table2: Nearly two-thirds of CFOs plan to allocate more than 2.1 percent of their revenue to sustainability in 2025

0–0.5%	0.80%
0.51–1%	3.00%
1.1–1.5	13.00%
1.51–2%	20.80%
2.1–2.5%	37.80%
More than 2.51%	23.00%
Not sure	1.60%

93% of CFOs see a clear business case for investing in sustainability

69% of CFOs expect a higher ROI from sustainability initiatives compared with conventional investments

61% of CFOs see sustainability investments primarily as a cost decisionrather than as something that creates value

TARGET MARKETS

Industry	How they Benefit	Our Impact	
Electronics Manufacturers	Access to high-quality, cost-effective raw materials such as lithium, cobalt, nickel, copper, and precious metals like gold and silver.	Reduced dependency on virgin materials, lower production costs, and enhanced sustainability credentials.	
Battery Producers	Reliable supply of recovered lithium-ion battery components for new battery manufacturing.	We promotes a circular economy in the energy storage sector by reducing environmental impact, and supporting the growth of renewable energy systems.	
Metal Refiners and Smelters	Consistent feedstock of valuable metals extracted from e-waste.	Diversifies their raw material sources, reduces reliance on mining operations, and contributes to sustainable metal production.	
Renewable Energy Sector	Affordable and sustainable raw materials for manufacturing solar panels, wind turbines, and other renewable energy infrastructure.	our operations accelerates the adoption of clean energy technologies by lowering production costs and promoting resource efficiency.	
Government and Public Sector	Access to recycled materials for public infrastructure projects and support for local recycling initiatives.	Enhances public services, promotes environmental stewardship, and supports national sustainability goals.	
Environmental Organizations and NGOs	Support for sustainable waste management practices and promotion of circular economy principles.	Our services advances environmental conservation efforts, and educates communities about the benefits of recycling.	
Small and Medium Enterprises (SMEs)	Cost-effective raw materials for manufacturing and production processes.	Boosts local economies, creates job opportunities, and fosters innovation in the SME sector.	
Investors and Financial Institutions	Investment opportunities in a growing and sustainable industry with strong economic and environmental returns.	Attracts green investments, supports financial stability, and promotes ethical business practices.	

VCs FUNDING

AFRICAN ENERGY STARTUPS

source: **Startup Energy Funding Database**

Acumen Fund

AF invest in companies that have significant operations or impact within East Africa, West Africa, etc. with focus on sectors in Energy, Agriculture, Health, and Education.

seed to early-stage | Debt, Equity

acumen.org

AECF / REACT

AECF (Africa Enterprise Challenge Fund) is a non-profit development organisation that supports innovative enterprises in the agribusiness and renewable energy sectors.

seed to early-stage | Grant

ecfafrica.org

African Emerging Ventures (AEV)

AEV's incubation and early stage investment model is a hands-on investment approach.

seed to early-stage | Debt, Equity

african-emerging-ventures.com

AHL Venture Partners

make minority equity, quasi-equity and debt investments in companies led by world-class teams taking innovative approaches to solving big problems in our sectors of focus.

seed to early-stage | Debt, Equity

ahlventurepartners.com

Akili Ventures

Akili empowers African entrepreneurs and operators, bringing them some of the best product, design and development expertise in the world.

seed to early-stage | Debt, Equity

akili.ventures

Alphamundi

AlphaMundi provides debt and equity financing to scalable impact ventures across sectors including Financial Inclusion, Sustainable Food and Renewable Energy.

seed to early-stage | Debt, Equity

alphamundigroup.com

Arigo

Arigo Ventures focuses on early-stage investment opportunities using a mix of own funds and investor capital for equity in a myriad of industries. They aim to partner with founders in the early stage of their initiative.

early-stage | Equity

arigo.co.za

Autodesk Foundation

Autodesk Foundation support early-stage startups with seed or Series A funding to de-risk and scale solutions focused on health and resilience, energy and materials, and work and prosperity.

seed, series, early-stage | Grant, Equity

autodesk.org

Bestseller Foundation

The main priority of the BESTSELLER Foundation is to help tackle one of the biggest challenges of our time – how to reduce waste, how to reuse and recycle valuable resources.

seed to early-stage | Debt, Equity

bestseller.org

Blue Haven – Ventures

Blue Haven seeks to put capital to work in highly productive ways: helping mission-driven projects and companies achieve scaleand supporting innovative entrepreneurs

seed to early-stage | Debt, Equity

bluehaveninitiative.com

Charm Impact

Charm was established to help mitigate two of the greatest challenges facing our generation: combating climate change and achieving universal access to clean and affordable energy.

seed to early-stage | Debt

charmimpact.com

DOB Equity

invest in businesses that positively contribute to a more social and sustainable society and deliver long-term profitability.

seed to early-stage | Equity

dobequity.nl

DOEN Foundation

DOEN supports initiatives that accelerate the transition to a more sustainable society. Specifically, DOEN focuses on pioneers with a business approach.

seed to early-stage | Debt, Grant

doen.nl

Energy4Impact

support energy companies who are looking for grant funding, whether it's from us or another source, with specialist advice on how to find it, how to secure it and how best to use it.

early-stage | Grant

energy4impact.org

ENTITIES DRIVING AND ENFORCING E-WASTE POLICIES

E-waste Producer Responsibility Organisation Nigeria (EPRON)

African Circular Economic Alliance (ACEA)

National Environmental Standards and Regulations Enforcement Agency in Nigeria

Basel Convention

Stockholm Convention

Nigeria's Federal Ministry of Environment

Africa Clean Up Initiative (ACUI)

StEP Initiative (Solving the E-waste Problem)

European Union (EU)

African Union (AU)

Electronic Industries Alliance (EIA)

Basel Action Network (BAN) Africa

WE'RE COLLABORATING WITH UNIVERSITIES, RESEARCH INSTITUTIONS, EQUIPMENT MANUFACTURERS, COMMUNITY ORGANISATIONS AND PROFESSIONAL ORGANIZATIONS TO TAP INTO THEIR EXPERTISE, RESOURCES, AND KNOWLEDGE. THIS PARTNERSHIP GIVES US A SIGNIFICANT INNOVATION ADVANTAGE.

CHALLENGES EXPECTED DURING THE COURSE OF THE PROJECT

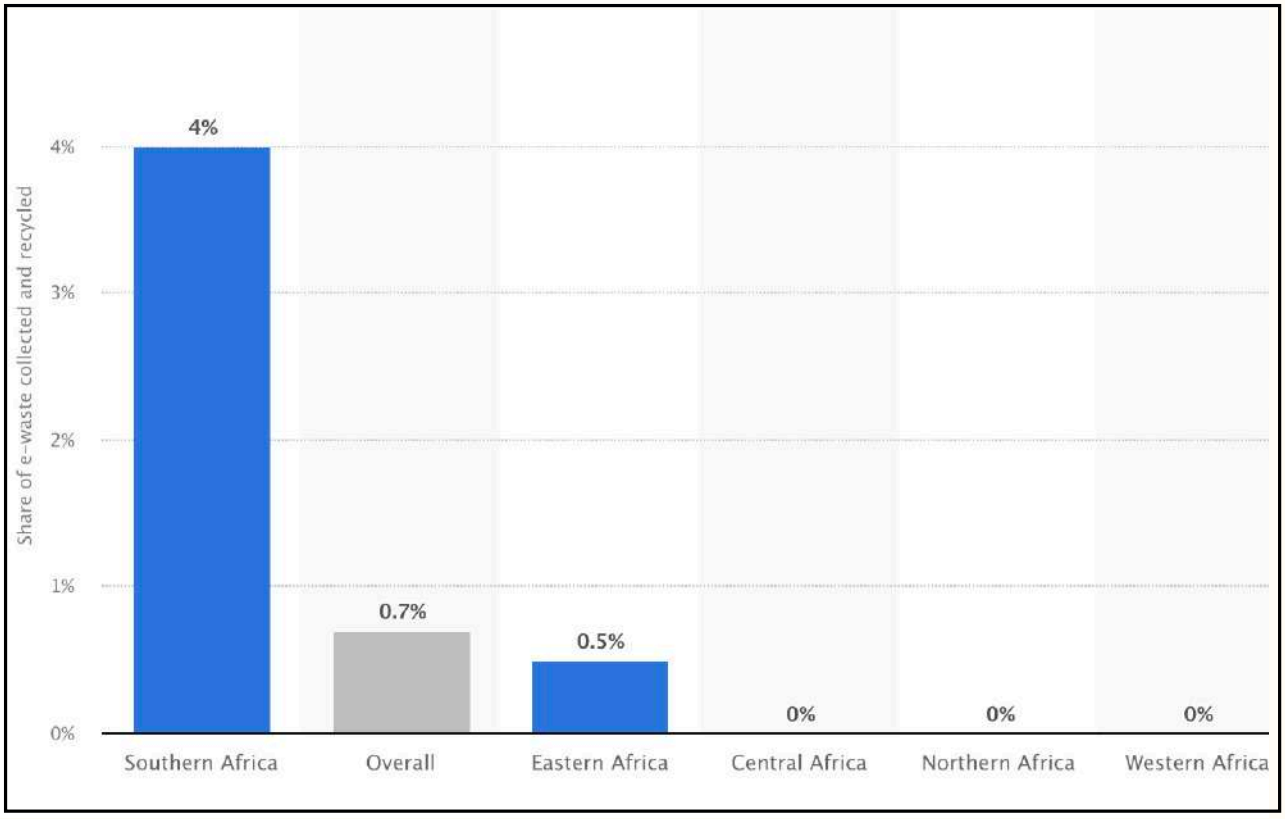
Like any groundbreaking venture, our journey comes with its share of challenges. Below, we outline these hurdles and we also discuss the mitigation strategies we've devised to overcome them ensuring sustainability, compliance, and long-term success.

1. SUPPLY CHAIN GAPS

One of the biggest obstacles facing our business is the lack of organized collection systems for electronic waste (e-waste) in Africa. The absence of formalized channels means that much of the continent's e-waste ends up in informal dumps or landfills. As shown in **table 1** in previous page, only South Africa has a collection target in place, this makes it difficult to secure a steady supply of raw materials critical to our process.

In 2022, only four percent of e-waste generated in southern Africa was documented as formally collected and recycled, and this was the highest share throughout Africa. The overall collection for recycling in Africa stood at 0.7 percent.

Figure 16: Share of e-waste documented as formally collected and recycled in Africa in 2022, by sub region



source: **statista**

Our Mitigation Strategy: 1

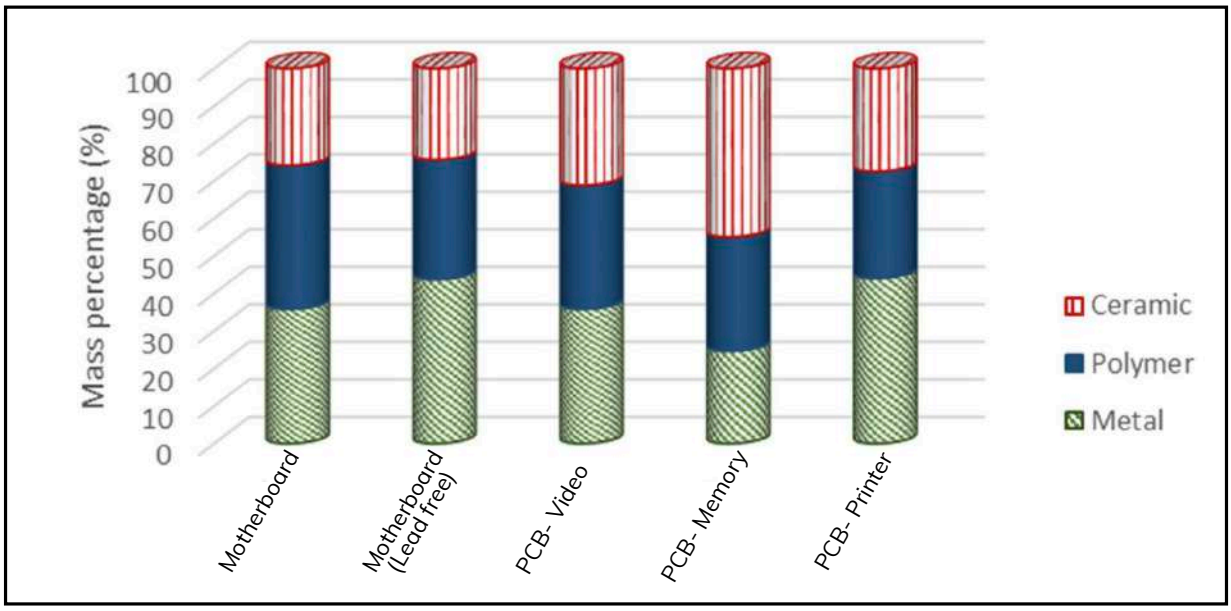
We recognize that building a reliable supply chain starts at the grassroots level. To tackle this issue, we're launching a dual-pronged initiative by collaborating with governments, NGOs, and private organizations to establish certified collection centers. These hubs will serve as drop-off points for individuals and businesses looking to responsibly dispose of their e-waste.
We are also leveraging on technology by digitally reaching out to independent collectors sell their e-waste directly to us through educational campaigns and incentives in form of competitive pricing for their e-waste.

2. DISPOSAL AND COMPLIANCE ISSUES

As noted in Figure 17, PCBs showed differences in their composition. It was found that the polymeric material on the motherboard was the most abundant, which corresponded to 38.3%. As for the lead free motherboard, memory card, the video card and the printer card, the polymer parts occupied the second position in the composition with percentages of 32, 30.5, 33 and 28.5% respectively.

Recycling processes inevitably generate byproducts, some of which require careful handling to avoid environmental harm. For instance, our circuit board recycling plant produces significant quantities of fiberglass, resins, and plastics annually. Similarly, our lithium battery recycling facility generates gaseous fluoroethane—a compound that must not be released into the atmosphere due to its harmful effects.

Figure 17: Mass balance of printed circuit boards (PCBs)



source: Tecnol. Metal. Mater. Miner., São Paulo, v. 16, n. 4, p. 453-463, out./dez. 2019

Our Mitigation Strategy: 2

To manage byproduct disposal effectively, we're exploring partnerships with manufacturers who can repurpose our non-hazardous outputs, such as fiberglass and resins, into new products. For hazardous substances like gaseous fluoroethane, we've invested in cutting-edge scrubbing technologies that neutralize emissions before they leave our facilities.

3. FINANCING CONSTRAINTS

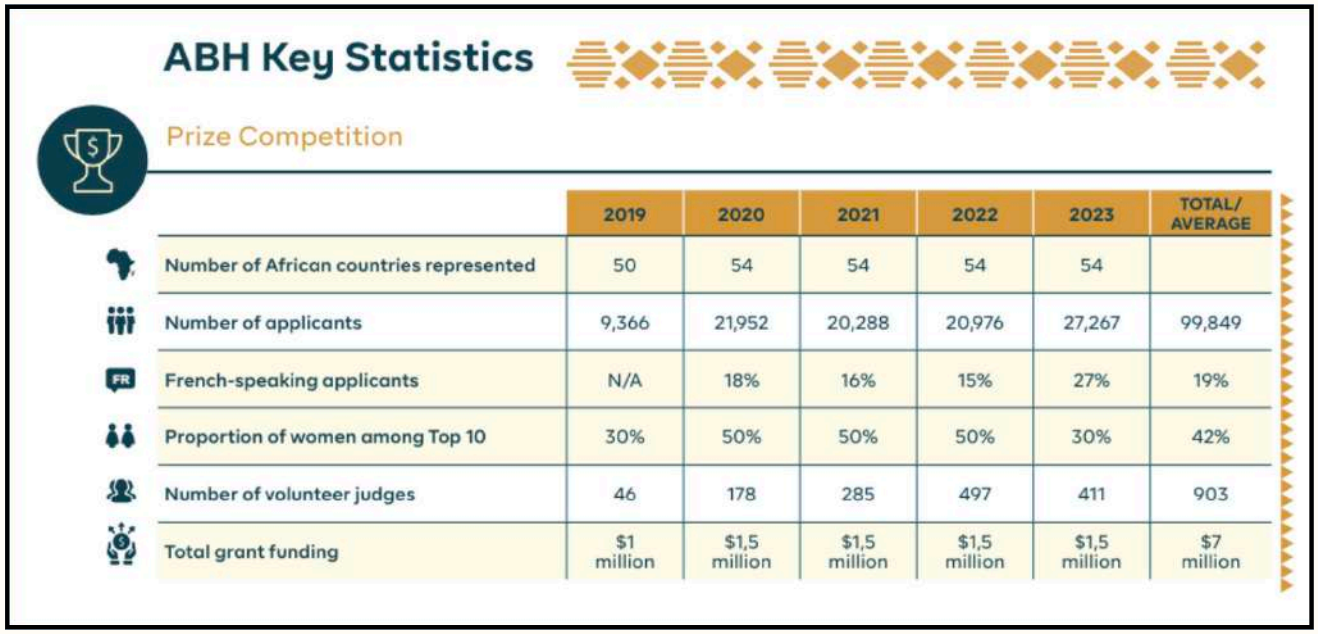
Access to capital remains one of the most pressing issues for African startups. Traditional lenders often demand collateral, which many early-stage ventures lack, while investors typically seek proven track records or tangible leverage before committing funds. For many startups, grants represent the only viable pathway to secure preliminary funding needed to develop prototypes, conduct research, or scale operations to a point where they become attractive to larger investors or lenders.

Considering that only 10 start-ups in Africa qualify for the African Business Heroes (ABH) grant which have grown exponentially in number of applicant from since 2019, the probability of winning an ABH grant in 2023 stands at a mere 0.036674% which is marginal.

Our Mitigation Strategy: 3

While grants remain part of our strategy, we're actively pursuing alternative funding models that reduce reliance on competitive grant programs. This includes revenue-based financing, where repayments are tied to future

Figure 18: ABH Grant Statistics (2023)



	2019	2020	2021	2022	2023	TOTAL/ AVERAGE
Number of African countries represented	50	54	54	54	54	
Number of applicants	9,366	21,952	20,288	20,976	27,267	99,849
French-speaking applicants	N/A	18%	16%	15%	27%	19%
Proportion of women among Top 10	30%	50%	50%	50%	30%	42%
Number of volunteer judges	46	178	285	497	411	903
Total grant funding	$1 million	$1,5 million	$1,5 million	$1,5 million	$1,5 million	$7 million

earnings, and strategic partnerships with industry players who see value in supporting sustainable ventures. We're also strategically identifying niche funding opportunities tailored to environmental sustainability and circular economy initiatives. We are also taking bold steps by engaging in Corporate Social Responsibility (CSR) Programs, these are corporations operating in Africa who allocates significant budgets to CSR initiatives aligned with sustainability goals.

4. FLACTUATION OF PRICES OF MINERALS

The minerals market had been turbulent for the past ten years which witnessed plummeting prices of lithium cobalt oxide, nickel, silver and gold whilst other key materials such as tin , iron , aluminum, lead, and copper prices decreasing as shown below.

Figure 19: Illustrates Sn, Ni and LiCoO2 per metric tonne

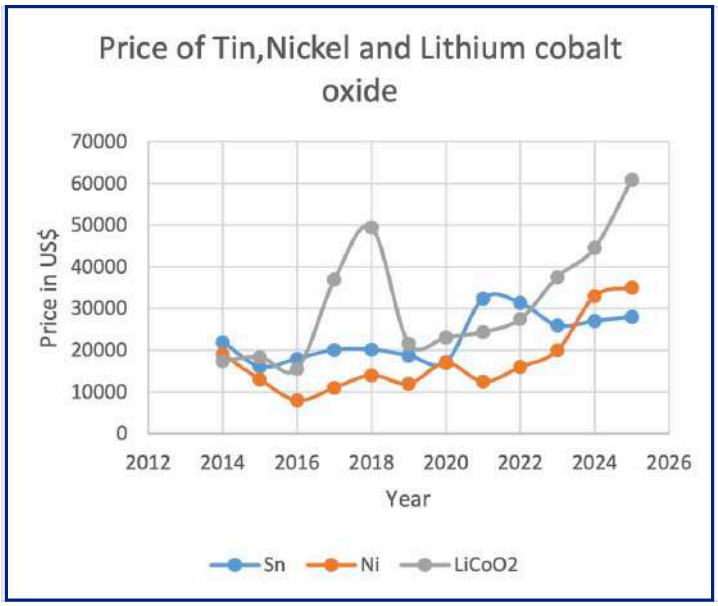
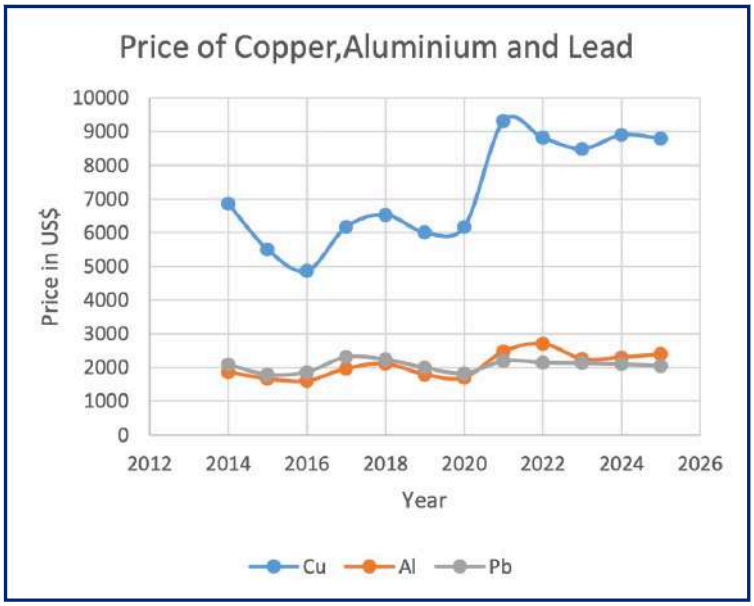
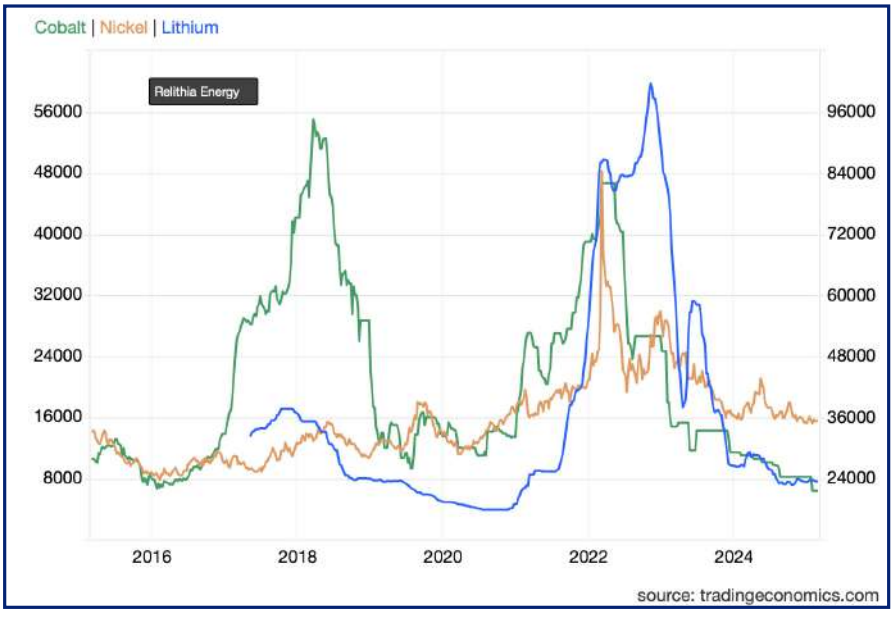


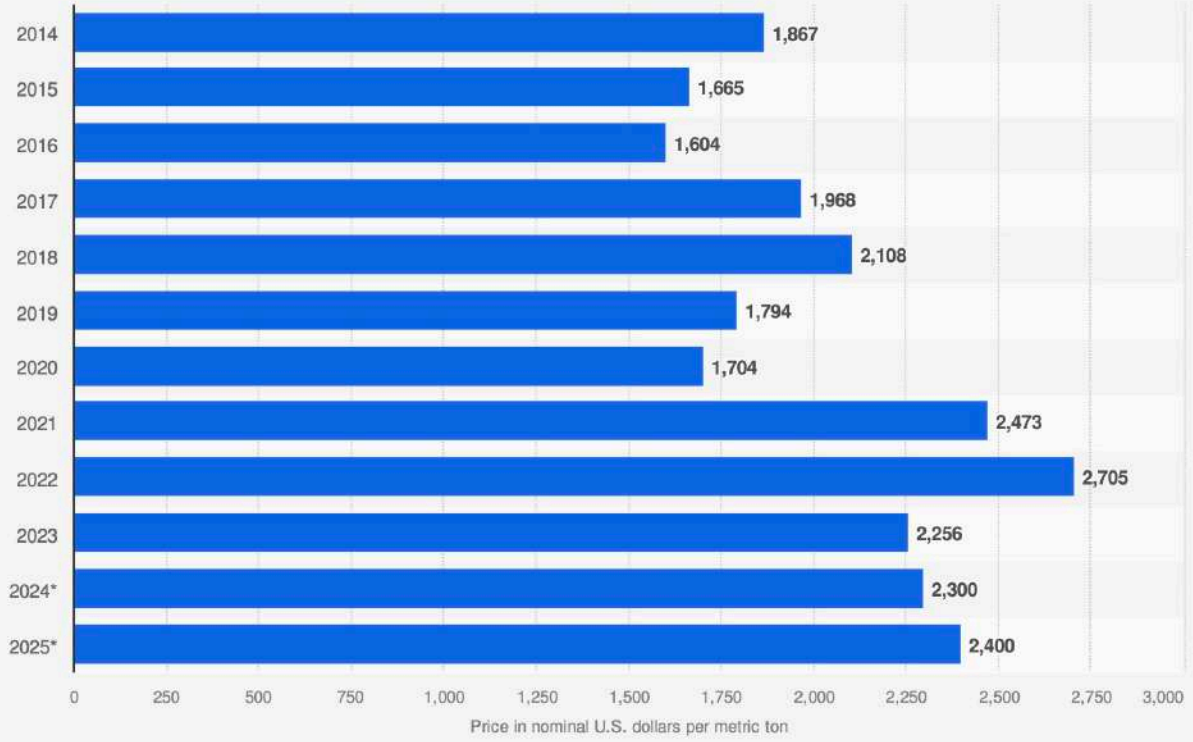
Figure 20: Illustrates Cu, Al and Pb per metric tonne



Price of cobalt, Lithium and Nickel have exhibited substantial volatility over the past decade. Notably, there was a sharp peak around 2018 for cobalt, followed by a steep decline. More recently, cobalt prices have shown another surge, reflecting increased demand driven by the growth of the electric vehicle (EV) industry and renewable energy sectors.



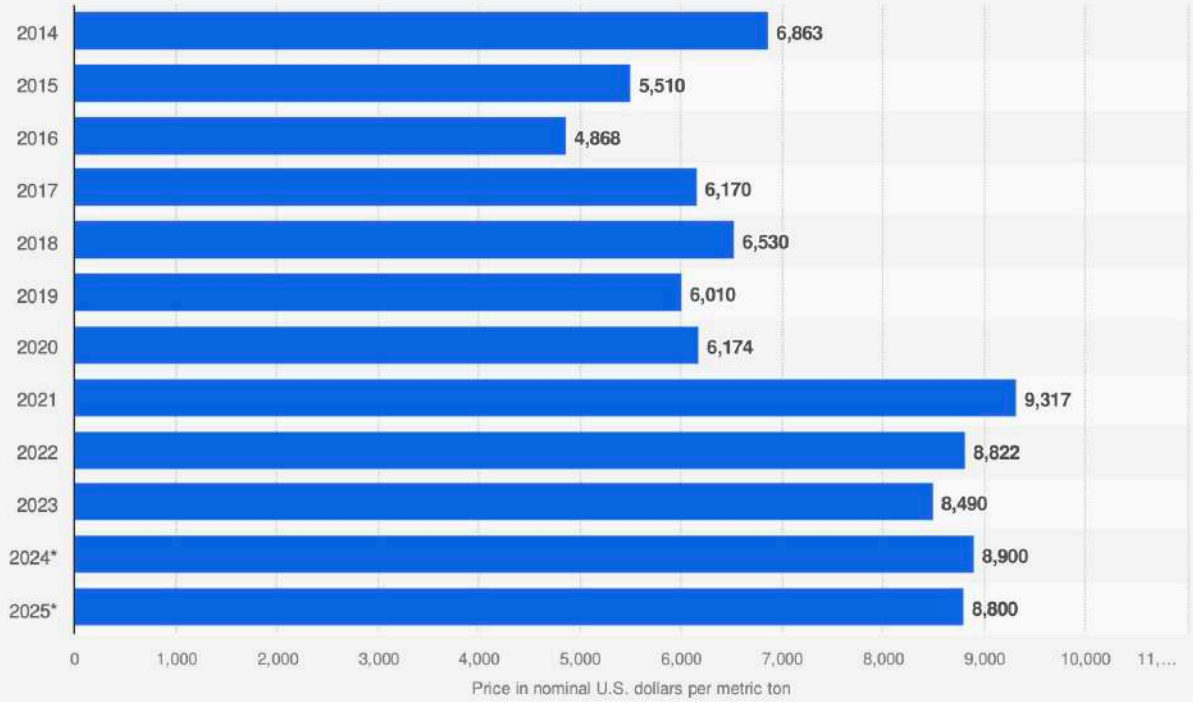
Average prices for aluminum from 2014 to 2025 (in nominal U.S. dollars per mt)



Source
World Bank
© Statista 2024

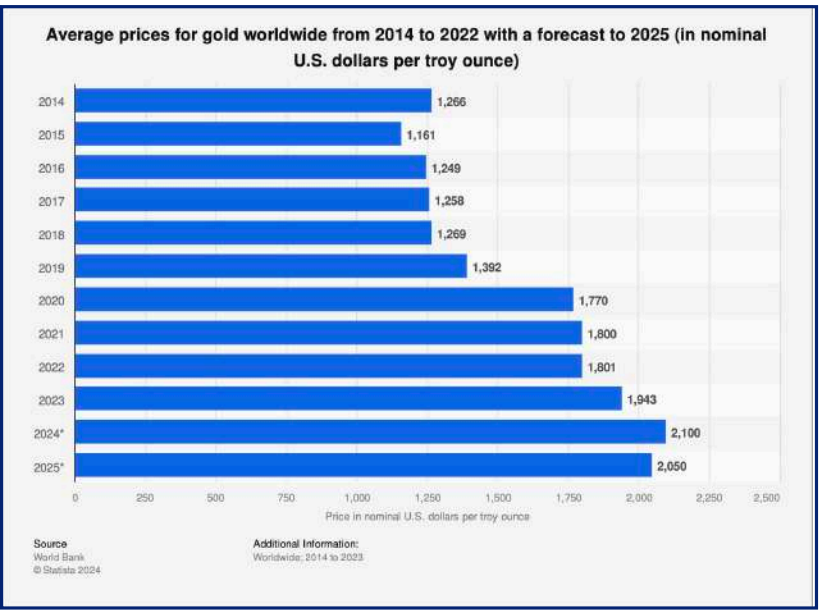
Additional Information:
Worldwide; 2014 to 2025

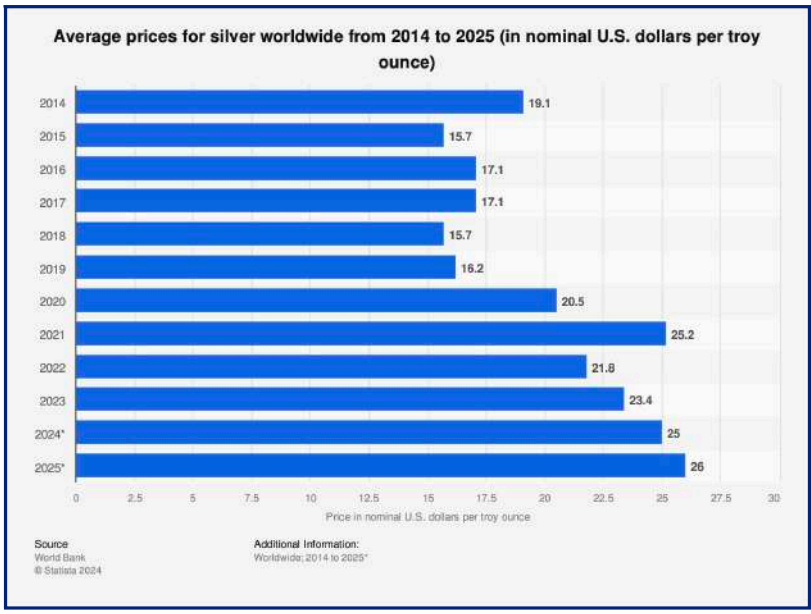
Average prices for copper worldwide from 2014 to 2025 (in nominal U.S. dollars per metric ton)



Source
World Bank
© Statista 2024

Additional Information:
Worldwide; 2014 to 2025*

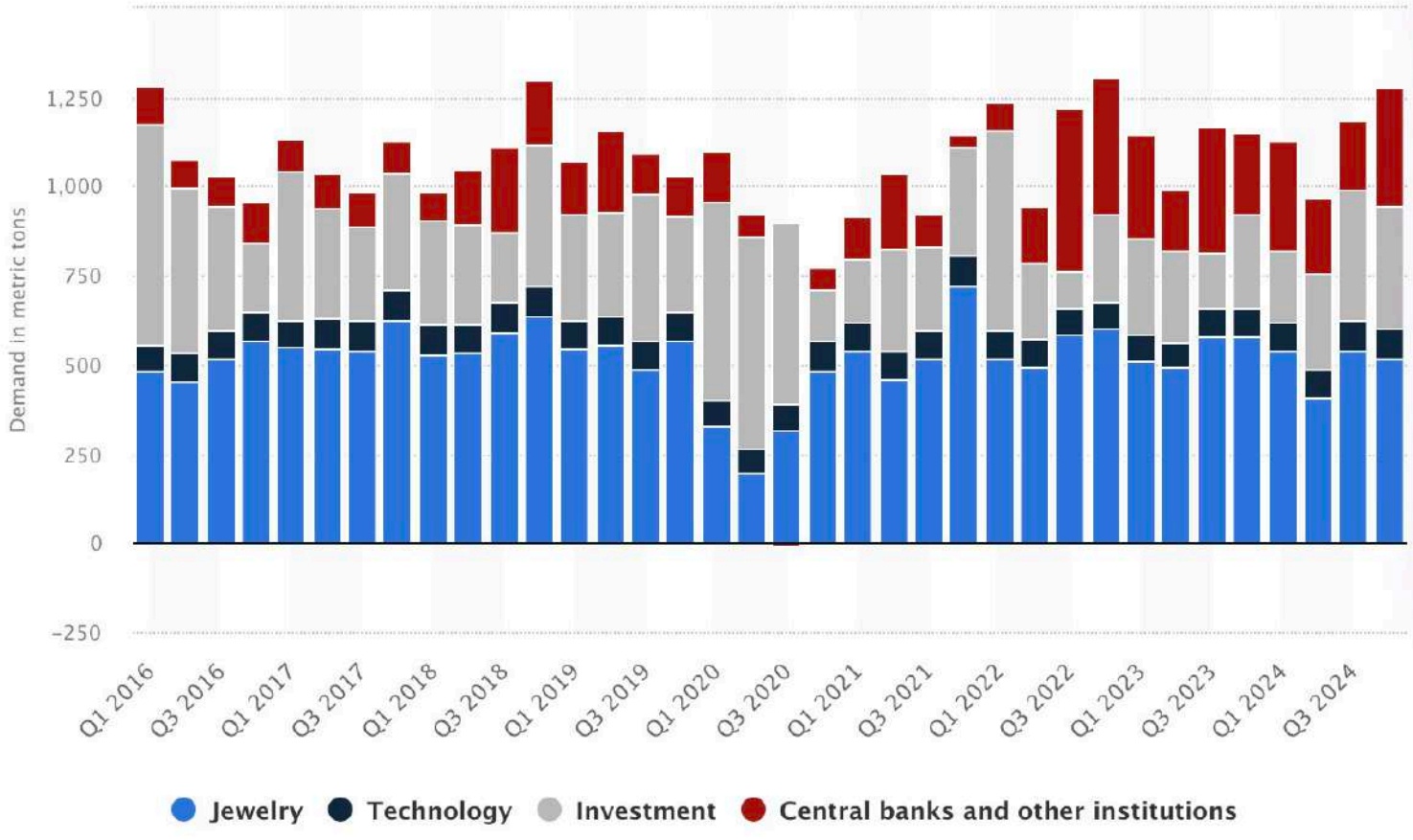




DEMAND AND SUPPLY OF METALS

Figure 26 shows the demand of gold for jewelry purposes which amounted to approximately 516.5 metric tons in the fourth quarter of 2024. This purpose was more than even technology, and most of the supply comes from mining, which is the gold ores. Notably to say, the amount of gold recovered from 1 ton of PC e-waste is more than that recovered from 17 tons of Au ore.

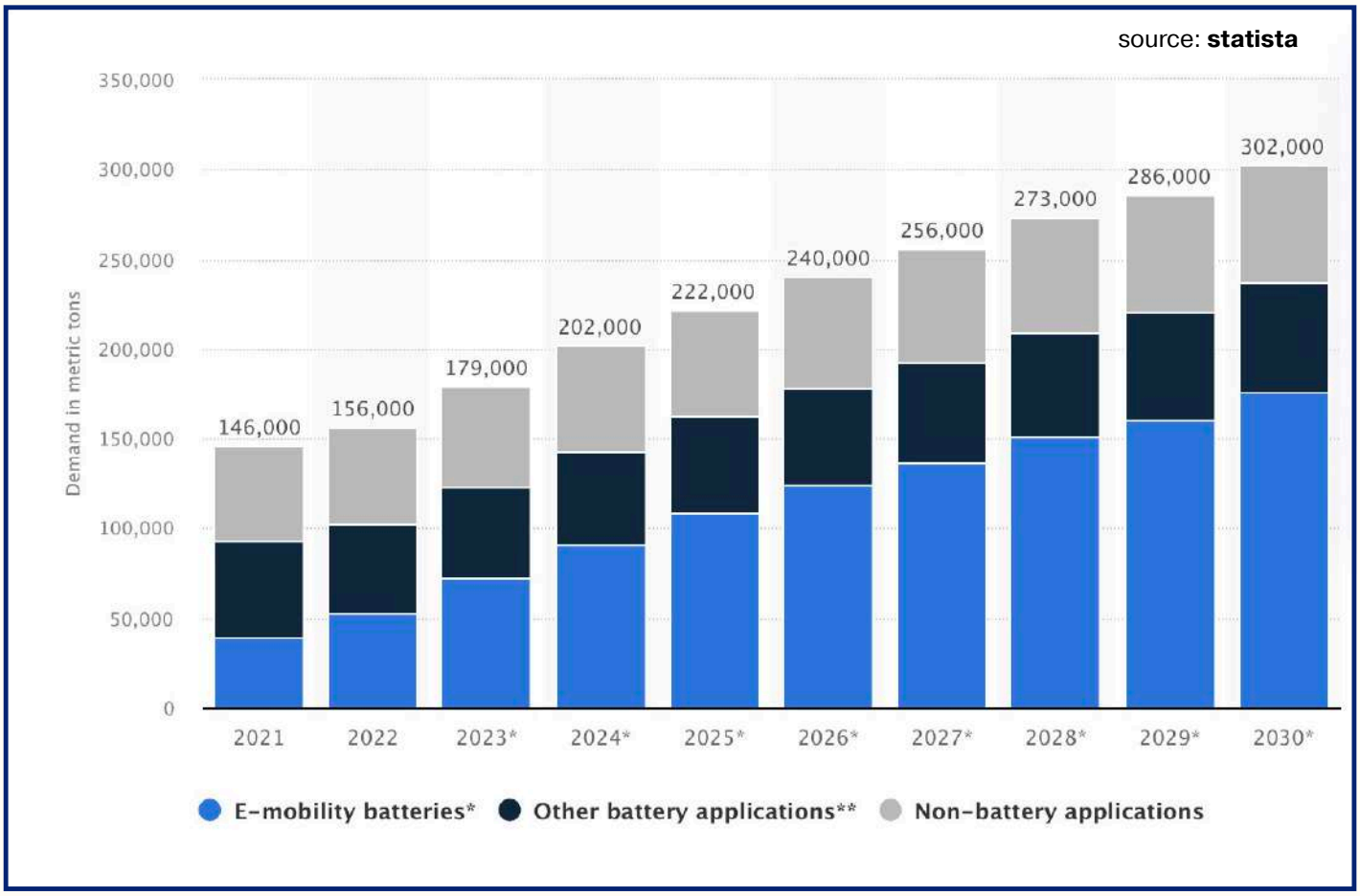
Figure 26: Demand for gold worldwide from 1st quarter 2016 to 4th quarter 2024, by purpose (in metric tons)



Generally, 300 g of gold can be extracted from 1 ton of waste mobile phone recycling, but only 3 g of gold can be extracted from 1 ton of average natural gold ore. Throughout history, gold has been desirable and in demand and has been characterized as a high-value commodity. This makes it very economically viable for us to recycle gold from WPCBs, as the profitability appears to be 100 times greater than what is obtained from the primary source.

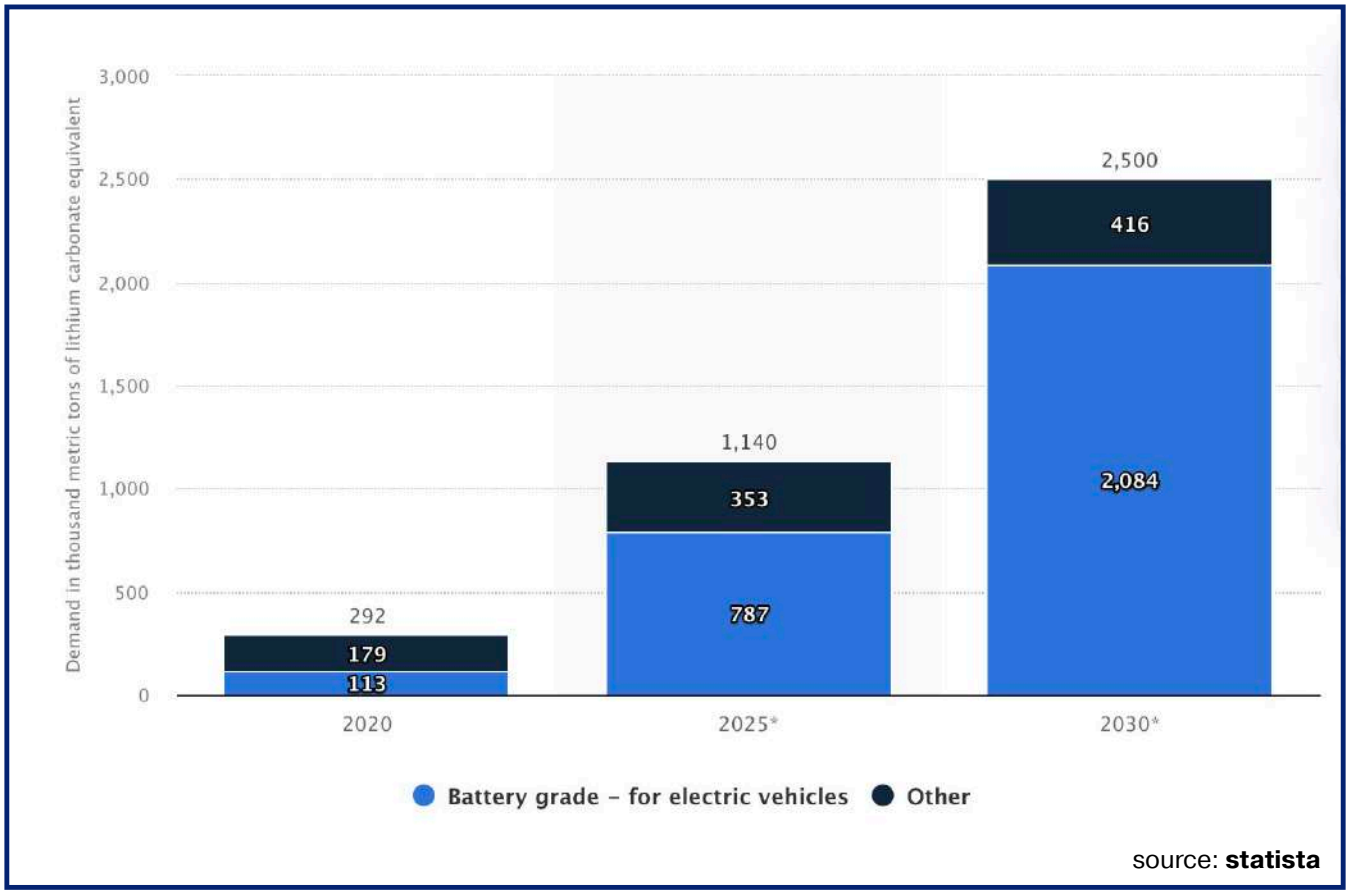
In addition to gold, there are several other valuable metals found in e-waste that are in high demand across high-tech industries and the rapidly growing electric vehicle (EV) sector. One such metal is cobalt , a critical component in the production of lithium-ion batteries. In fig 27, it is forecasted that by 2030, e-mobility batteries alone will account for an estimated 176,000 metric tons of global cobalt demand. In contrast, non-battery applications of cobalt are projected to reach only 65,000 metric tons globally by the same year. This underscores the pivotal role cobalt plays in powering the EV revolution and highlights its increasing importance as a strategic resource.

Figure 27: Demand for cobalt worldwide in 2021 and 2022, with a forecast from 2023 to 2030, by end-use (in metric tons)



Similarly, the demand for lithium —another essential element in battery manufacturing is set to skyrocket. In 2020, global lithium demand stood at approximately 292,000 metric tons of lithium carbonate equivalent (LCE). However, projections indicate that

Figure 28: Demand for lithium worldwide in 2020, with a forecast for 2025 and 2030, by application
(in 1,000 metric tons of lithium carbonate equivalent)



by 2030, this figure will surge to around 2.5 million metric tons , representing nearly a ninefold increase. All of this growth which is largely driven by the accelerating trandition to renewable energy and widespread adoption of EVs. The ability to extract high-demand metals like cobalt and lithium from e-waste offers a significant business advantage for us, as it reduces reliance on traditional mining while meeting the needs of industries driving the green energy transition.

Black mass

Silver

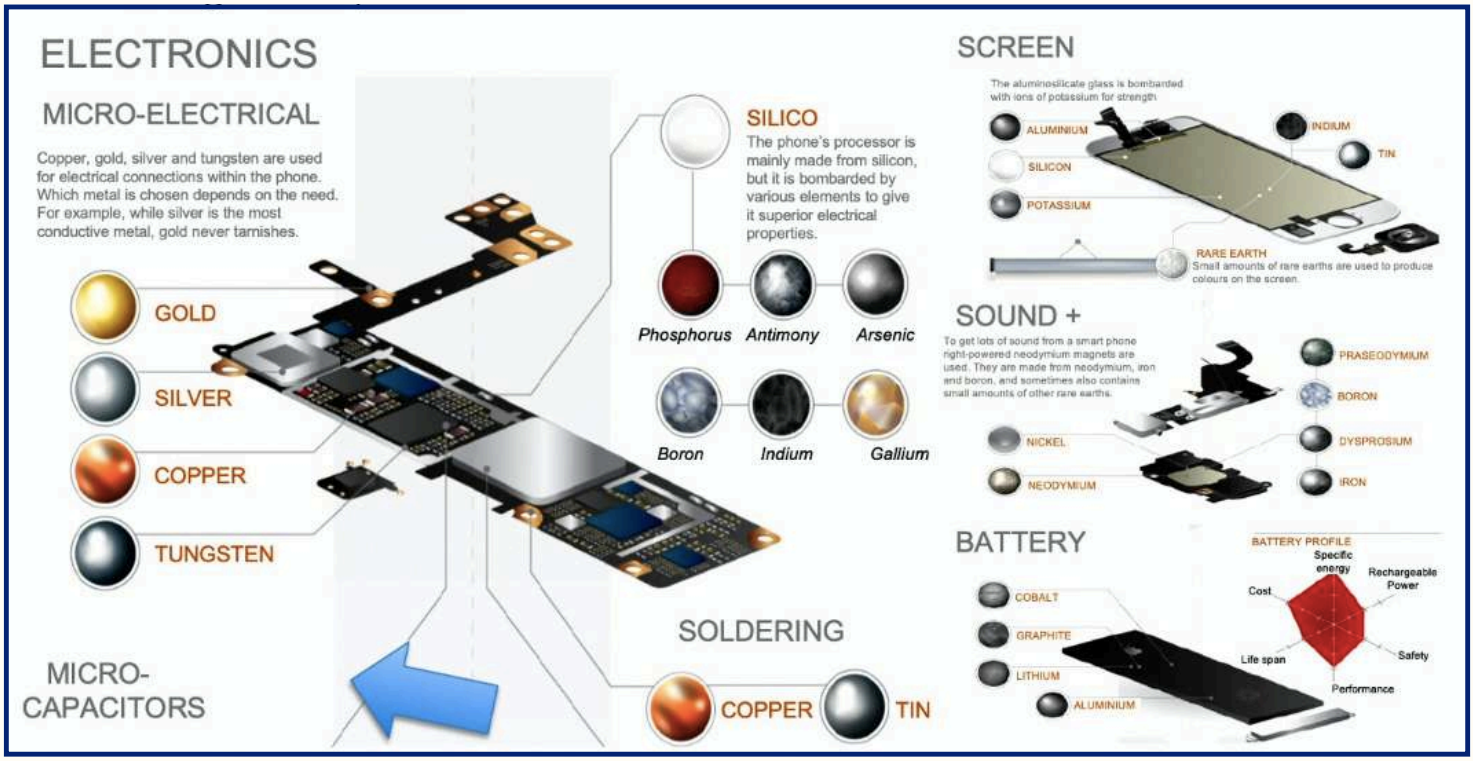
Palladium

Gold

Table 3: **PCB material composition** - *parts per million(ppm)*

Metals about 40%	**avg.(%)**	**Ceramics about 30%**	**avg.(%)**	**Plastics about 30%**	**avg.(%)**
Copper (Cu)	16.5	SiO_2	22.5	PE	13
Aluminium (Al)	4.6	Al_2O_3	7.7	PP	4.8
Iron (Fe)	4.6	Alkali-earthoxides	6.0	PS	4.8
Lead (Pb)	2.6	Titanates-micas	3.0	Epoxy	4.8
Tin (Sn)	3.3			PVC	2.4
Nickel (Ni)	2.85			PTPE	2.4
Zinc (Zn)	1.2			Nylon	0.9
Antimony (Sb)	0.25				
Gold (Au) (ppm)	2,300				
Silver (Ag) (ppm)	2,305				
Palladium (pd) (ppm)	2,025				
Platinum (Pt) (ppm)	17.5				
Cobalt (Co) (ppm)	2,000				

Table 3 above shows representative material compositions of WPCBs by wt%. The materials can be categorized into three groups: organic materials, metals, and ceramics. A mobile phone can contain over 63 elements from the periodic table. Metals represent 23% of the weight of a phone, the majority of which is Cu, while the remainder is plastic and ceramic material.



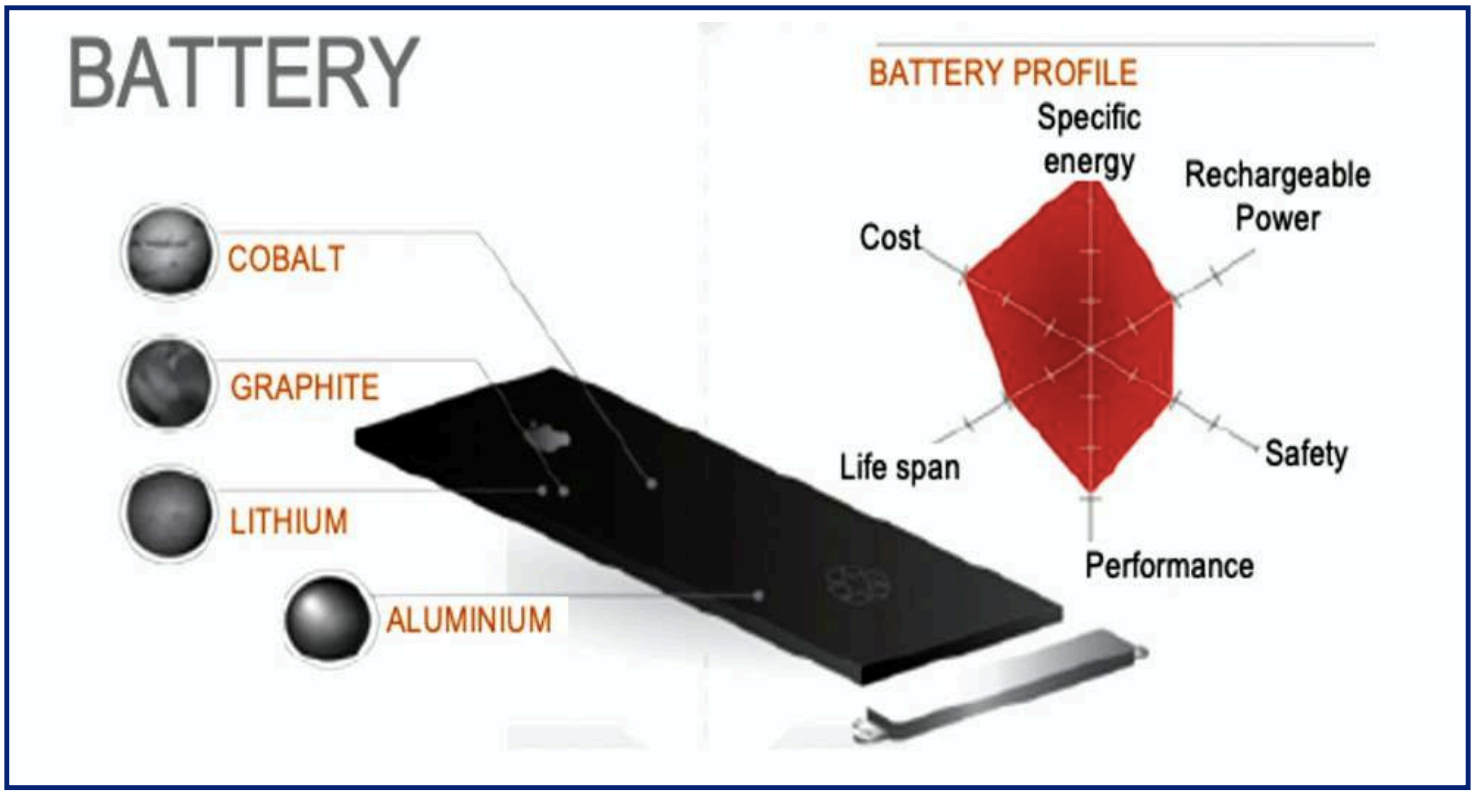


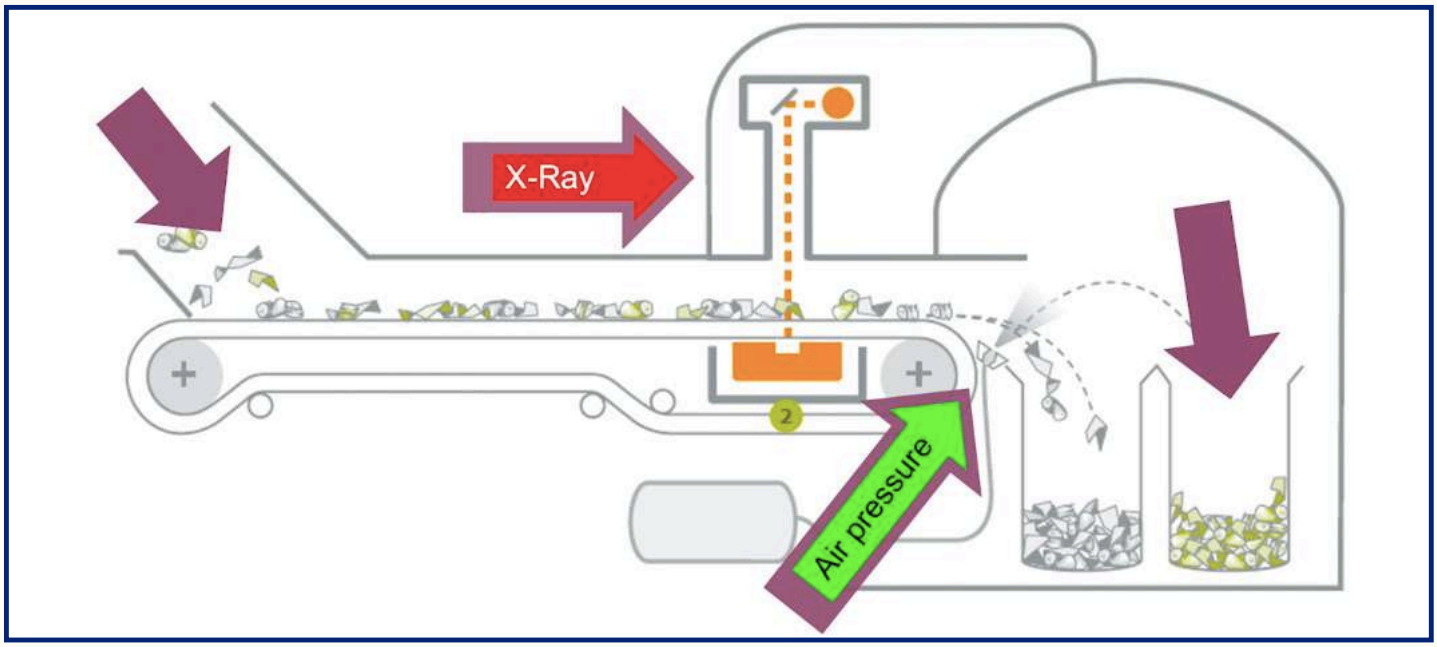
Figure: Different battery chemistries and their applications

Chemistry	Cathode	Anode	Intr.	Applications
LCO	$LiCoO_2$	Graphite	1991	Mobile phones, laptops, camcorders
LFP	$LiFePO_4$	Graphite	1996	EVs (China and early US), Energy Storage Systems (ESS), Power tools, utility vehicles.
LMO	$LiMn_2O_4$	Graphite	1996	EVs (Nissan Leaf, Renault Zoe), Power tools, Medical , devices, E-bike
NCA	$LiNiCoAlO_2$	Graphite	1999	EVs (Tesla), Laptops, Medical devices, E-scooters
NMC	$LiNiMnCoO_2$	Graphite	1999	EVs (Most non-Chinese cars since 2017), Power tools, Energy Storage Systems

SORTING

To begin our battery recycling process, we first focus on sorting. This is essential because not all battery chemistries can be handled by a single recycling line. Sorting is critical for us to ensure the quality of our products. After sorting the batteries, we proceed with various other processes such as discharging, shredding, and different separation methods.

Automatic Sorting - X-Tract Sorting Principle (TITECH)



Automatic Sorting

Figure: Magnetic Electrodynamic Separation

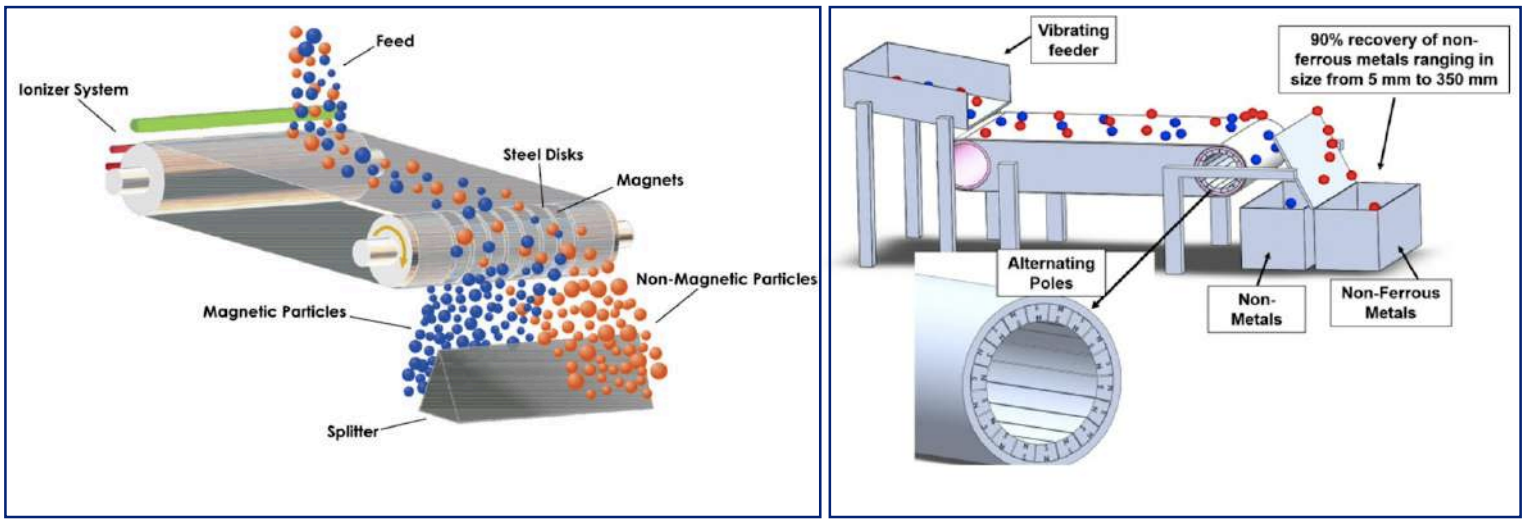


Figure: Industrial-scale Electronic Components (ECS) Separation

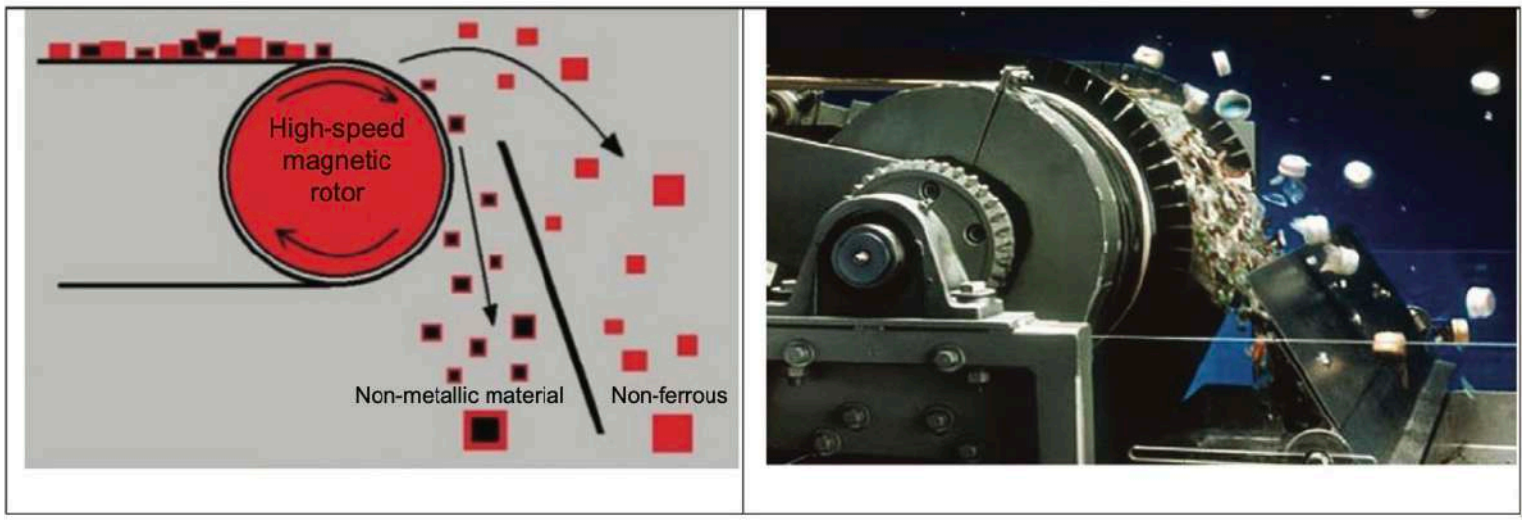


Figure: Flow sheet following ECS dismantling.

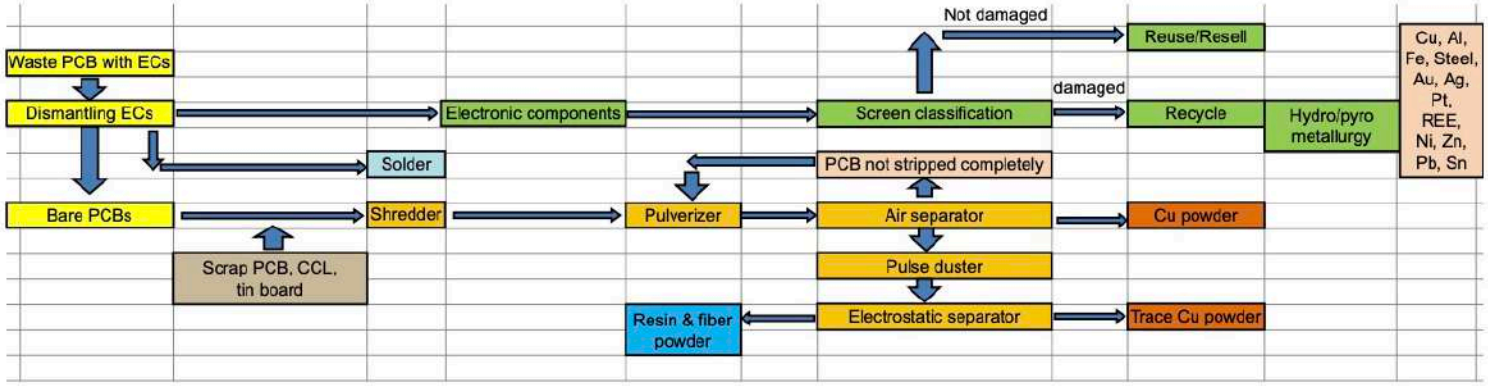


Figure: Physical properties of metals and plastics in WPCBs and potential physical separation method selection for metal recovery.

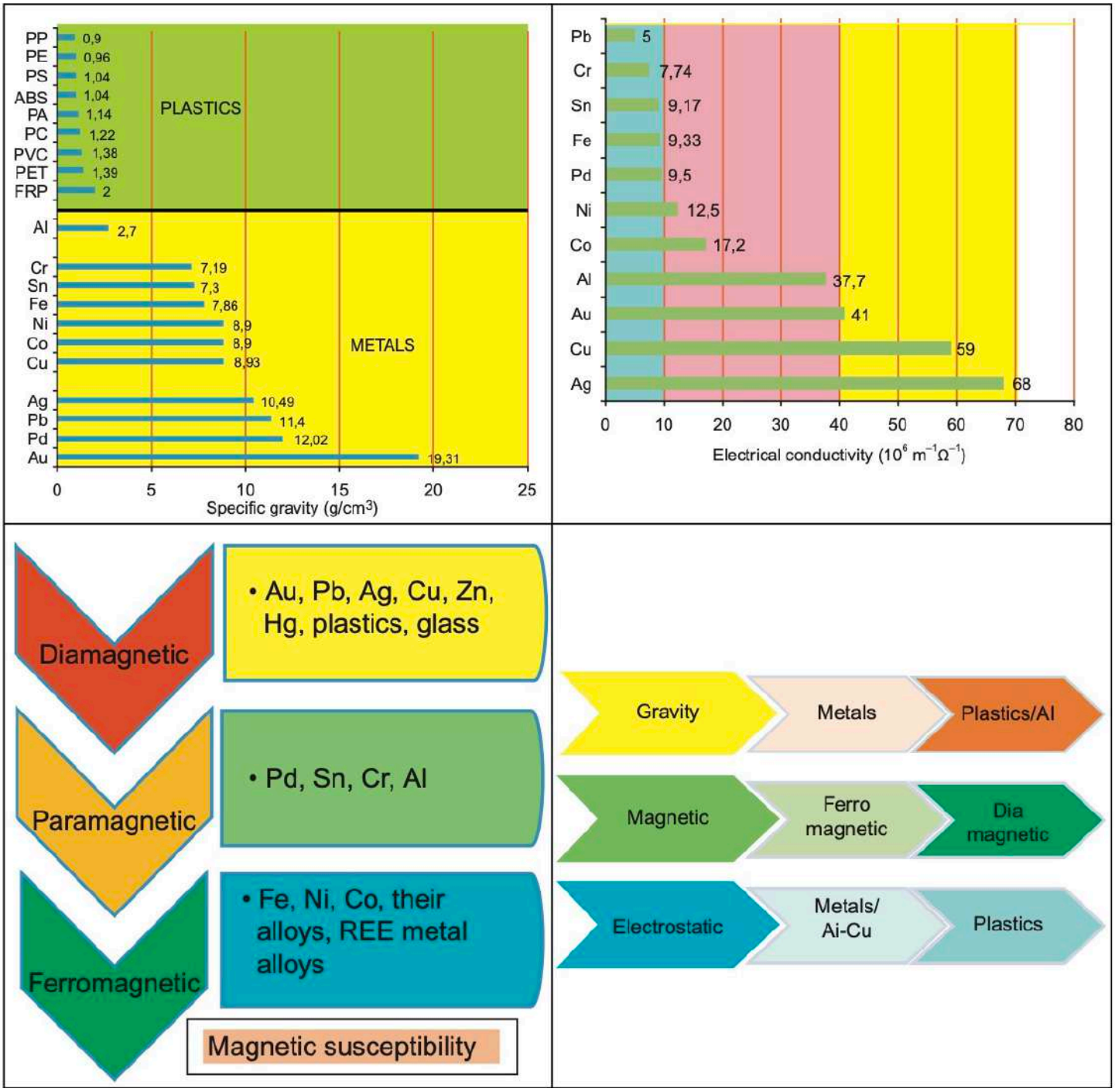


Figure: PCB Recycling line Industrial layout

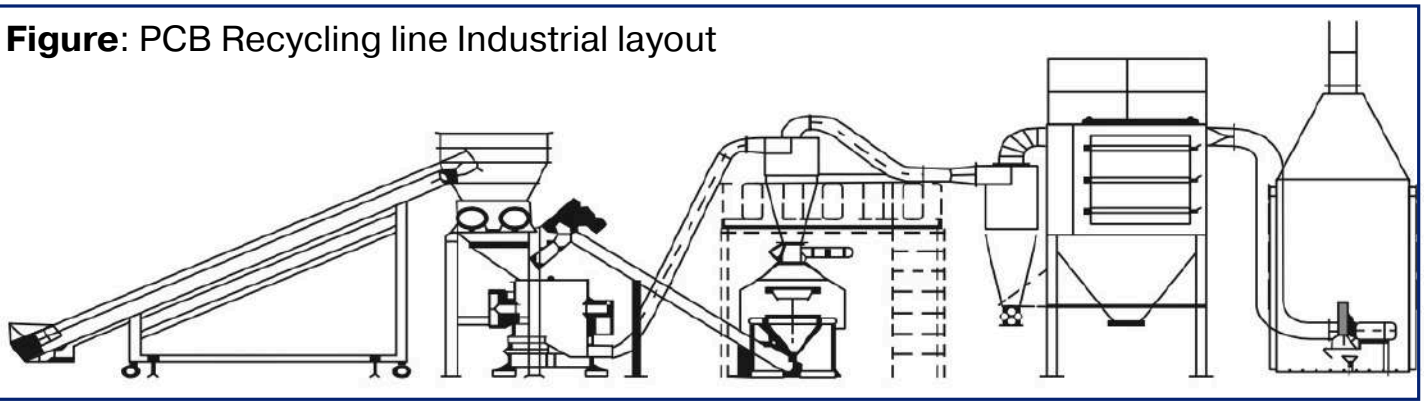
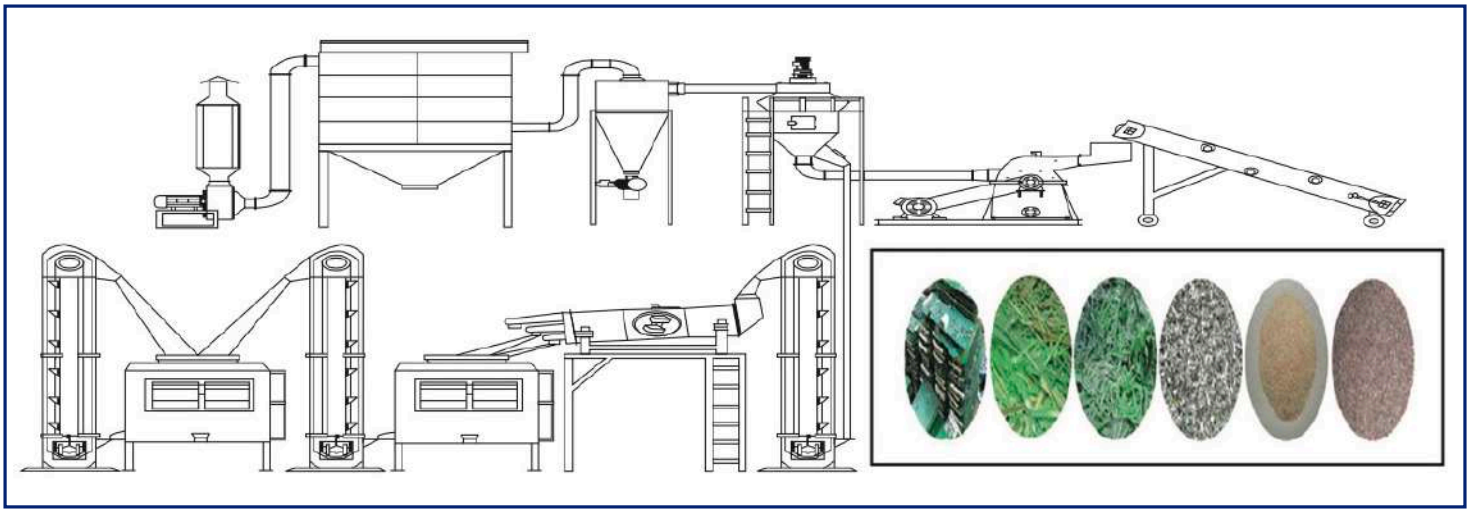


Table: Typical intrinsic value of populated WPCB.

Metal	% by wt	Value per kg ($) \$	Intrinsic value (/kg)	Intrinsic value (%)	Average Profit Margin (%)
Gold (Au)	0.0025	65,000	16.25	72.8	5-15
Palladium (Pd)	0.0010	30,000	3.00	13.5	5-15
Platinum (Pt)	0.001	35,000	0.35	1.6	5-15
Silver (Ag)	0.1	800	0.80	3.6	10-20
Copper (Cu)	16	9	1.44	6.5	10-20
Tin (Sn)	3	25	0.75	3.4	10-20
Lead (Pb)	2	2	0.04	0.18	5-15
Nickel (Ni)	1	20	0.20	0.9	5-15
Aluminum (Al)	5	2.5	0.13	0.6	<5
Iron (Fe)	5	0.5	0.03	0.13	<5
Zinc (Zn)	1	3	0.03	0.13	<5
Total			**22.22**		

apex.com, Kitco.com, metalsdaily.com, lme.com (March 05, 2025).

Figure: PCB recycling flowsheet with ECSs, industrial equipment, and feed-products obtained.



Cash Flow Analysis

The project require approximately US$4,000,000 to kickstart and have potential to generate US$84 000 000 in profits.The capital is paid back with equity with allocation of shares depending on the terms and conditions agreed upon between the company team and the investors.

Pre-Startup	Year 1 ($)	Year 2 ($)
Cash at Hand	4,000,000	151,100
Cash Sales	---	
Purchases (lands and equipments)	3,314,520	
Gross Wages and and Allownaces	16,000	
Permits and Licensing	100,800	
Raw materials (WPCBs, WLIBs)	171,800	
Utilities	6,780	
Auto, Delivery, Travel	4,000	
Solar	200,000	
Construction of Buildings	100,000	
Insurance	2,000	
Maintenance	---	
Accounting and Legal	3,000	
Taxes	20,000	
Cash Position	**151,000**	